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Three-Cylinder Locomotives

European railroads have been using three-cylinder, single-expansion locomotives for many years and the type has been quite popular in several countries. Moreover, a study of the locomotives of advanced design which have been brought out recently in England, France and Germany shows an increasing tendency toward the use of three cylinders. One of the locomotives of this type, described in this issue, contains a number of features of more than usual interest. Hitherto there has been comparatively little consideration given to three-cylinder locomotives in this country and but few have been built. Some of the reasons why European locomotives differ from those used in America are more restricted clearances and track conditions which do not admit of as high an axle load as is employed here. While three-cylinder locomotives are not quite as simple a piece of machinery as the common type with only two cylinders, they offer certain clearly defined advantages. They are better balanced; therefore, are less severe in the strains set up in track and bridges and run with greater smoothness. The turning torque is more uniform and it is consequently practical to use a lower factor of adhesion. As there are six instead of four exhausts per revolution, the draft on the fire is more even and the tendency is toward better combustion. These are points which are being given increasing consideration and will probably lead to the building of some three-cylinder locomotives in this country in the near future.

Training Shop Foremen

When higher mechanical department officers can detach themselves long enough from a consideration of labor problems, they discuss the need of a greater number of trained shop men and especially foremen. One of the most practical plans which we have yet seen for training railway shop foremen is described on another page of this issue. The author, Hugo Diemer of La Salle Extension University, has been a shop superintendent and industrial engineer and has some interesting comments to make on railroad shop mechanics and foremen who have come under his observation. Acknowledging the resourcefulness of the average shop foreman, he warns against a tendency to be satisfied with makeshifts which might be satisfactory in an emergency, but which would be time-consuming and costly for continuous production work. He points out most forcefully the value of trained foremen and outlines the development of foreman training courses, describing in a general way a typical course.

Without attempting to steal the author's thunder, we may say that he recommends the conference method (with home study) of training foremen under the direction of group leaders. Obviously, capable group leaders must first be obtained and these men can then transmit to the foreman an idea of their function in industry and the best methods of fulfilling their duties—namely, to fill the gap between management and workers, translate company policies, direct men tactfully but firmly and be executive leaders in the true sense of the word. Referring to the great possibilities of foreman training, the author says in the last paragraph of the article, "Those who are active in the movement and who have had an opportunity to observe and measure its results, feel confident that ultimately it will prove as important as scientific management in bringing about greater industrial efficiency and in maintaining America's industrial supremacy." How long will it take the railroads to realize the benefits that can be secured from such training?

Departmental Co-operation Is Needed

The natural tendency in any large organization, such as that of a railroad system, is for the various departments to become self-centered. As contact with other departments is lost, the work is carried on with less and less knowledge or consideration of the problems or needs of those outside of the particular department even though there may be no interdepartmental jealousies. As an illustration, the engineering department not only has jurisdiction over tracks, yards and stations, but also over the design of bridges, shops and terminals. Engineering knowledge is required for the design of either a bridge or a shop building to secure adequate strength and economy in the use of structural materials. There is, however, a vast difference between the after use to which the two are put. If the bridge is of ample strength, is properly erected and is kept protected by paint against corrosion, it meets all requirements. An error of judgment in the design of a bridge may slightly increase the first cost and consequently add to the fixed charges for capital but a mistake in the layout of a shop or engine terminal may result in a considerable and unnecessary addition to the cost of operation which goes on year after year as long as the building remains in use or until alterations are made to help the situation. In too many instances important shop buildings are designed without sufficient investigation in regard to the exact way in which they are to be used. After preliminary plans have been drawn up the details of the project should be gone over carefully with the mechanical department, and by the mechanical department is meant not only the superintendent of motive power but also the subordinate officers who will be called upon to operate the shop after it has been built. The men who spend their time in a shop and are responsible in a large measure for the operating costs should realize better than anyone else the effects which even minor changes in arrangement may have upon the question whether the plant will be a convenient and economical one. Manufacturing concerns, which as a rule are obliged to consider all operating costs far more rigidly than is the case at present on a railroad, are at an advantage when it comes to the question of shop design and equipment. All departments are usually located at one point and the heads come in daily contact with those in other departments. There may be a

plant engineer but he usually reports to the chief engineer who has charge of the design of the plant as well as of the product. The works manager or superintendent is also in close contact with the chief engineer and all parties work out together the various problems in connection with the design of a shop building or addition. With the increasing demand for a reduction in railroad operating costs it is important that greater consideration be given to shop layouts and that the engineering and mechanical departments work together on the problems arising from the growing or changing demands for rolling stock handling and maintenance.

College Men in Railroad Work

The question of the college man in railroad work is an old one but is still a vital issue both for the man and for the railroad. The leading motive power officers on some of the largest systems have evidently considered that there was a need for such men and that there were places where the knowledge obtained from a college training, after having been supplemented by a period of practical experience, could be used with advantage to the road. This is evident from the fact that considerable time and thought has been given to mapping out special apprenticeship courses covering two or more years which would give young men a broad and varied experience in the numerous phases of railroad motive power work. A large proportion of men when they leave college appreciate the fact that they are lacking in practical experience, which can be obtained only in the field of activity which they select for their life work, but probably few if any put on overalls and do the varied work in shop, roundhouse and on the road, from stripping a locomotive to firing, with the intention of becoming a skilled machinist or of indefinitely performing manual labor. Any young man who completes a term as a special apprentice shows that he is at least interested in what he is doing, is not afraid of hard work and is not deterred by a low rate of pay. A less promising young man would have taken a job as a draftsman or sought some other position where the pay would have been greater, the work pleasanter and the future prospects at least as good. There are undoubtedly instances of men who have started in railroad work and who have shown later on that they were better suited to other fields of activity. However, far too many have started and after serving for a number of years have found that there was apparently little prospect of advancement in the railroad field and after making a change have been highly successful in manufacturing or other work. Many a valuable man has been lost to the railroads from an indifference to his future after his training has been completed. If he was worth training he must have some value other than as a mechanic. To train a man and then fail to realize anything from the effort and expense of furnishing such a training is a wasteful procedure, discouraging to the man and a hindrance to the future progress of the mechanical department.

More Drop Forging Work Needed

One feature of blacksmith shop work not emphasized as much as its importance warrants is drop forging. Only a comparatively few railroad blacksmith shops are equipped with drop hammers and trimming dies and where this equipment is installed it is usually insufficient to meet the needs. One of the most interesting practices at the Reading locomotive shops, described elsewhere in this issue, is the drop hammer work in the blacksmith department. The experience shows that with drop hammers of the proper capacity and trimming dies to remove the flash, drop forging offers an efficient, quantity-production method of making many small parts used in locomotive and car repair work. In most cases one operator can insert the blanks in the furnace, form the parts under the drop hammer and remove the flash under the trimming dies, the labor cost being thus reduced to a minimum. The forgings are formed rapidly and after enough have been made to pay for the cost of the dies, the unit cost for each forging is greatly reduced, representing a considerable saving over the cost of buying or manufacturing by other methods. In addition, the fact that the metal is worked under the drop hammers results in improved quality forgings which are less likely to fail in service than are castings.

As specific examples of the drop forging work at Reading shops, the dies and methods of drop forging heavy 2¼-in. to 3-in. hexagon nuts and column guides for freight car truck bolsters are noteworthy. Other drop forged parts include guide blocks, eccentric rod jaws, cylinder cock jaws, hose clamps, etc. A further advantage results from manufacturing these parts locally under the drop hammers in that they may be secured on short notice, thus avoiding the delayed deliveries which frequently occur when forgings are purchased from outside manufacturers. Considering the many advantages of drop forging, it should be introduced far more extensively in railroad shop practice than is now the case.

Back Shop and Roundhouse Co-operation

One effective way of expediting locomotive running repair work is by a closer co-operation of the shop and roundhouse supervisory forces. In spite of the fact that back shop and roundhouse men work in the same department under the jurisdiction of the same mechanical superintendent, or superintendent of motive power, there is usually more or less rivalry and sometimes antagonism between the two groups. The roundhouse foremen are directly on the firing line. They feel that their needs are of paramount importance and often are none too tactful in demanding material and parts from the back shops. The shop supervision on the other hand, often with practically no roundhouse experience, does not appreciate the extremities caused by lack of material or repair parts at terminals and often feels, therefore, that roundhouse foremen have an exaggerated opinion of their own importance.

One valuable result of the present strike of the shop crafts has been the fact that in many cases mechanical department foremen, by conference and otherwise, have been brought in closer contact with each other and have a better understanding of mutual problems. In a specific case, one back shop was closed as a result of the strike and the entire shop supervision sent to an important nearby terminal to help out. These men had an excellent opportunity to observe at first hand the resourcefulness of the roundhouse foremen in turning locomotives under difficulties. The way locomotives were held up for lack of material and the real emergency created by a broken side rod or crosshead was brought home to these shop foremen in a forceful manner. Almost to a man they returned to their shop with a better understanding of roundhouse needs and a determination to pay more prompt attention in the future to communications from that source.

Master mechanics and roundhouse foremen on the other hand can greatly assist the back shop forces and incidentally themselves by giving closer attention to work reports, making sure that these reports are accurate and explaining any weaknesses developed by locomotives. In this way defects can be corrected and will not be overlooked when locomotives go to the back shops for heavy repairs. Another practice not followed as generally as seems desirable is to let the shop supervision know in advance what will be needed in the way of new material or machine parts on locomotives soon due for a shopping. For example, if the cylinder bushings on a certain locomotive are almost down to the limit and will not stand another reboring, the shop forces should be advised

so that new bushings can be rough machined before the locomotive comes to the shop. If locomotives ride hard, reverse with difficulty, or pick up speed slowly, these facts should be reported to the shop forces who often will be able to correct the defects by a little extra attention. Good results all around will follow a closer co-operation of the back shop and roundhouse supervisory forces.

Be Prepared for Car Orders

One of the surprising conditions met with in railroad operation is the sudden and often unexplainable changes in traffic. Thus a road which recently was short of box cars and planned to build a large number found before construction was started that it had a surplus of that class of equipment and numerous demands for flat cars that could not be supplied. Although many of the parts for the box cars had been made, the road considered working over all the material for use in flat cars, as it seemed likely that the increased net earnings by having these cars in service promptly would more than make up for the higher cost of construction.

This incident explains why the mechanical department is so often called upon to prepare designs and specifications for cars on short notice. When confronted with the prospect of losing traffic if equipment cannot be furnished, the higher executives are likely to disregard the desirability of making a thorough study of the design before cars are built. Hastily drawn plans have been the direct cause of much unnecessary expense for maintenance, and the only way to insure that new cars when acquired will be a credit to the mechanical department is to keep designs of each type constantly under way. Those who are directly responsible for the design should be given every opportunity to study conditions in shops and yards. They will discover many reasons why cars fail and why they are expensive to maintain that would never be suspected by a man who stayed in the drafting room. Few cars designed today can be criticized as lacking in strength in the essential parts, but it is also important that cars should be as light as they can consistently be made, easy to repair and well protected against corrosion. Few cars meet all these requirements.

It is interesting to lay out a new design and then to analyze each feature critically, applying the experience with existing types and trying to eliminate their defects. A comparison of the final result with the original will usually show a surprising number of changes and will convince anyone of the necessity of giving long and painstaking attention to every new design.

What Is "Ordinary Handling"?

The last of the so-called combination defects were eliminated from the interchange rules in 1918, and in the 1918 code owners were held responsible for all damages except those due to certain specified causes for which responsibility obviously lies with the handling line. That extensive combinations of sill defects were not to be considered in themselves evidence of unfair usage irrespective of the conditions under which they developed, was made even clearer by the interpretation added to Rule 43 in the 1919 code. But the note which replaced the interpretation under this rule in 1920 and an arbitration decision since rendered have completely reversed this position, placing the burden of proof on the handling line if fair usage is claimed in connection with extensive underframe damage.

The application of the present rule hinges on what constitutes the "ordinary handling" of which the delivering line must present positive evidence if it is to shift the responsibility for the cost of repairs to the owning road. The fact that when fair usage is claimed there is usually little evidence on which to base such a claim other than the absence of such conditions as derailment, cornering, sideswiping, etc., in effect defines this term as that handling which will not cause "damage to more than five longitudinal sills on wooden underframe cars, more than four longitudinal sills on composite wooden and steel underframe cars, more than three longitudinal steel sills on steel or steel underframe cars and both steel center members on tank cars with two longitudinal sills only." In other words, what constitutes abusive treatment depends on the condition and the strength of the design of the cars handled.

For many cars now in service operating conditions on the road as well as in both flat switching and hump yards make ordinary handling, as thus defined, impossible. It is true, of course, that if no check is placed on the severity of the operating stresses to which cars are subjected, it will be impossible to develop designs of sufficient strength to withstand them, and it might be argued that placing the liability for damages on the handling line would tend to check carelessness in switching and handling trains. But the responsibility for damage to lading and to home cars when on the home line should accomplish all that can be expected in this direction, while overprotection of the interests of the owner tends strongly to perpetuate worn out equipment and inadequate designs.

This, no doubt, is understood by the Arbitration Committee, but before holding that body responsible let it be remembered that it can go no farther in modifying the intent of the rules than the consensus of opinion of the representative membership of the American Railway Association will permit. What is necessary, then, if pressure is to be exerted effectively against undue protection of the car owner, is an active and co-ordinated interest in the modification of this rule by all roads principally affected as handling lines. The *Railway Mechanical Engineer* ventures the opinion that a careful study of the situation will demonstrate that the interests of the handling lines in this matter outweigh those of the owning lines, and that the interests of the roads as a whole would be better served by a return to the 1919 rule.

Some Comments on Internal Grinding

Practically all the advantages of external cylindrical and flat surface grinding, emphasized many times in these columns, hold with equal force for internal cylindrical grinding. Internal grinders are now made of sufficient power to remove metal rapidly, leaving holes which may have almost any desired degree of accuracy and greater smoothness than can be obtained by any other method. The possible uses of internal grinding machines in railroad shops are too numerous to describe in detail but a few typical examples may be mentioned for the benefit of shop men unfamiliar with the machines.

One of the most extensive uses of internal grinders is for truing worn holes in side rods and valve motion work. These holes often become out of round and rough in service, it being difficult if not impossible to get a satisfactory fit for new bushings to be applied. Internal grinding presents the best method of truing these holes and getting a smooth surface. A boring machine could be used but the grinder does the job more quickly and takes off only enough metal to true the holes. Another extensive use of the small internal grinding machine is for truing the holes in case-hardened valve motion bushings. These bushings are usually made in quantity on turret lathes or automatics, then being case-hardened and pressed into the valve motion parts, such as links, eccentric rods, combination lever, lift shaft, etc. The process of case-hardening almost invariably changes the size of the bushing holes slightly, often distorts them and leaves a rough surface due to scale. The bushings are hard so that they cannot

be reamed or filed and the only satisfactory way of truing the holes and bringing them accurately to size is by grinding. The appearance of bushings after grinding will convince any skeptic that, on the ground of smoothness alone and consequently better bearing qualities, these bushings should be ground.

As described in a previous issue of the *Railway Mechanical Engineer* a prominent Eastern railroad has for some time followed the practice of standardizing valve motion pins and bushings, manufacturing them in quantity from bar stock on automatic machines. The bushings are standardized in graded sizes, the pin fits in the bushings being ground before it is known on which locomotive they will be applied. Sufficient stock is left on the taper bearings of the pins and the outside diameters of the bushings so that these fits can be made quickly at the time of application. This work would be absolutely impossible without the use of internal grinding machines and the railroads owe a greater debt than is commonly appreciated to the manufacturers of this type of machine. Large amounts of time and money have been spent in developing the machine and bringing it to a point where it can efficiently perform almost any internal grinding job.

Another valuable use of the internal grinder in railroad shops is for truing the main piston bushings in triple valves and other air brake operating valves. The internal grinder is particularly adapted for this operation because of the great accuracy required. It is generally recognized that parts of the air brake equipment including the valves must be machined and fitted with greater accuracy than is needed in general locomotive repair work. Air will leak through a small hole and it does not require much of a leak at a critical point to render air brake valves inoperative. The fit of the main piston ring in a triple valve may be mentioned as an example and this ring cannot be sized properly and ground in unless the bushing is almost perfectly round and smooth. Experience has shown the value of internal grinding machines for truing these bushings and reclaiming valves which would otherwise have to be scrapped or returned to the manufacturers. The latest improvement in internal cylinder grinders has been the hydraulic arrangement for traversing and reversing the table absolutely without shock. These machines should be a valuable addition to any shop on account of the convenience of operation, the accuracy and smooth quality of the work performed, and above all the saving in the cost of repairs which can be effected by their use.

Weight of Passenger Cars

FOR a long period almost every passing year has seen a slow but steady increase in the weight of passenger cars; this increase has not been accompanied by a corresponding increase in carrying capacity. In freight car design there also has been a marked increase in weight and size but the ratio of dead weight to carrying capacity has never been lost sight of; in fact, the aim has ever been to obtain a higher proportion of revenue load. In passenger car design the points given most consideration are those which have added to the comfort of the passengers or have appealed to their æsthetic sensibilities. Coupled to this has been an effort to secure maximum strength to withstand damage from collision or derailment. Designs have clearly shown the influence of the Pullman car. Railroad officers seem to have given little heed, however, to the fact that it is expensive to haul cars that weigh more than necessary—the Pullman Company does not have to furnish the locomotives to haul its cars and naturally can afford to ignore weight to a much greater degree than the railroads.

The extent to which weight has mounted should be appreciated when we find sleeping cars weighing over 7,000 lb. for each berth. Moreover, a dead weight of 2,000 lb. per passenger seat is by no means unusual for modern all-steel day coaches. For strictly suburban traffic the weight is less but even here 1,200 lb. per passenger seat is better than the average.

Another striking change which has been brought about by the increased weight of passenger cars has been the radical modifications in the design and type of locomotives which are used to haul heavy passenger trains. Not many years ago the Atlantic type locomotive began to be displaced by the Pacific type. It seemed for a time as though the latter type would meet all requirements for an indefinite period, but Pacific type locomotives steadily increased in size until they weighed some 270,000 lb. for the engine alone and reached 2,500 hp. and a tractive effort of over 40,000 lb. This was not sufficient, however, and now we find the Pacific type being superseded by the Mountain type in many places. Locomotives of the last type now weigh over 350,000 lb., are rated at more than 3,000 hp. and develop a tractive effort of nearly 60,000 lb. Looking back for a brief period of less than 30 years, we find important trunk lines then building for heavy, fast passenger service an American type locomotive weighing less than 125,000 lb., with 19 in. by 24 in. cylinders, 20,000 lb. tractive effort and 1,100 hp. This is quite a contrast when compared with some of the locomotives ordered recently.

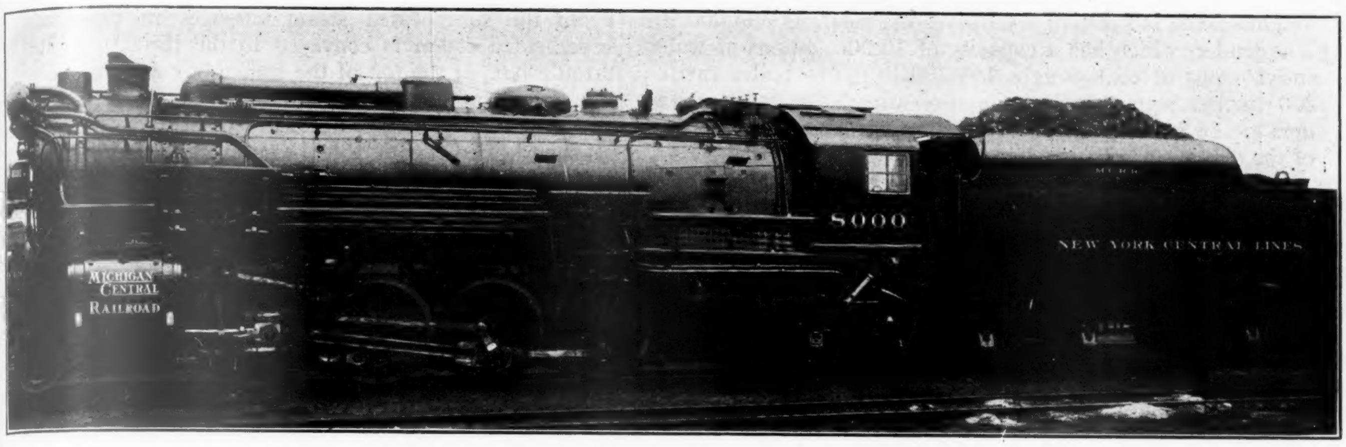
The modern builders of gasoline rail motor cars appear to realize the need of holding the dead weight to a minimum far more clearly than do many of the railroad officers with whom they have to deal. In fact the motor car men frankly state that the reason for the failure of older designs of such cars to meet expectations was largely due to their heavy weight brought about by attempts to carry out railroad demands. If the operating economies desired are to be realized the weight of these cars must not exceed that which can be handled by engines already developed for highway trucks. Thus we find such cars seating 35 persons and weighing less than 25,000 lb. or about 670 lb. per passenger seat.

It would seem to be time not only to call a halt to the increase in passenger car weight, but to study seriously the problem of reducing the weight of such cars. A far-reaching lesson might well be learned from the attempts of motor car designers to limit the weight of their cars. Future designers looking back to our present practices in passenger cars will undoubtedly consider them crude, wasteful and decidedly lacking in the application of engineering.

New Books

OPERATING ENGINEER'S CATECHISM OF STEAM ENGINEERING. *By Michael H. Gornston, 428 pages, 4½ in. by 7½ in., bound in leather. Published by D. Van Nostrand Company, New York.*

This book is of special interest and service to younger operating engineers and students. It contains 1,300 questions and answers which, as a rule, are clearly and concisely stated. Its form will appeal particularly to those who are not accustomed to concentrated study and is, for this reason, rather elementary in its treatment of the different subjects. The author is a steam engineer in the department of education of the City of New York and in writing the book evidently had in mind the engineer who wished to prepare himself for such examinations as are required for civil service positions, municipal or state. The book, however, will also be of use in the library of older and more experienced engineers, for reference purposes. Among the subjects discussed are heat, steam, combustion, boilers, engines and condensers, together with chapters on the practical management of boilers, engines and auxiliary machinery. Pumping machinery, steam heating, stokers and also pulleys and belting are included. The book is well printed and of convenient size although it would have been improved by the use of more illustrations. An excellent index of 32 pages adds considerably to its value.

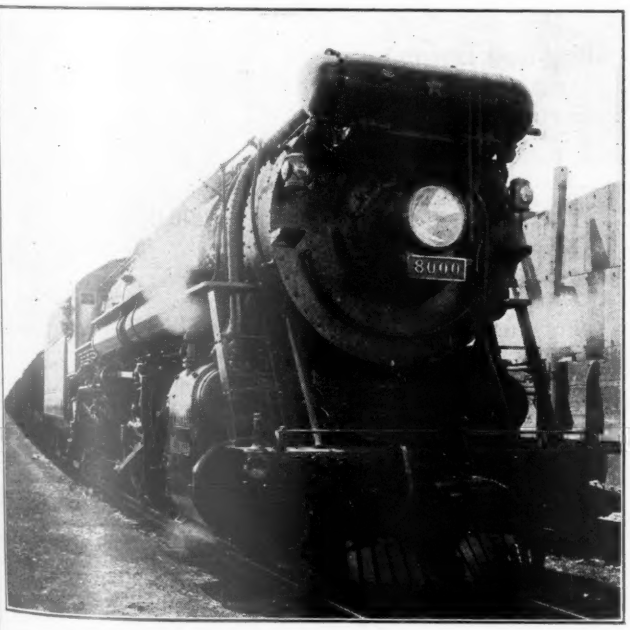


Many Radical Changes Have Been Made in the Construction of This Locomotive

A Remarkable Mikado on the Michigan Central

Maximum Power Per Unit of Weight and Utmost Efficiency in Use of Fuel Keynotes of Design

FOR the past month the Michigan Central has been operating a Mikado type locomotive built by the Lima Locomotive Works, which incorporates many new features of design. On account of the unusual character of this new motive power the railroad has not heretofore made public any of the details of its construction. The following general description has now been given out by the New York Central Lines:



The Front of the Locomotive Presents a Striking Appearance

An extraordinary locomotive "No. 8000," which is expected to prove a most important contribution to motive power progress, has just been put in service on the Michigan Central. In numerous details of its design and construction it is radically different from any locomotive previously built and in general appearance it presents striking departures from the familiar features of the ordinary locomotive.

The locomotive was planned and constructed under the personal direction of President A. H. Smith of the New York Central Lines, who specified the several most important main accomplishments to be sought by the new design and made provision for the use of every up-to-date improvement of proved worth, brought to the last degree of refinement for economy and efficiency. The engine contains features never before incorporated in any locomotive.

Locomotive 8000 in its preliminary tests and subsequent daily service hauling heavy trains between Detroit and Toledo, has performed in a way highly satisfactory to the New York Central officials and the builders. In its initial road test, it hauled 100 heavily laden coal cars and later easily pulled a train of 140 cars containing more than 9,000 tons of coal, indicating a capacity of more than 150 cars and load in excess of 12,000 tons.

Locomotive 8000 is considered the last word in efficiency and economy in freight motive power. The principal advantages which it is expected to demonstrate are:

(1) For its weight, it will deliver more power than any other locomotive in the world.

(2) It will develop more power per ton of coal consumed than any locomotive ever built.

(3) It will prove a locomotive easier to operate and repair than its predecessors, this making for quick turnarounds and safety.

Locomotive 8000 was designed and built to expedite the movement of heavy fast freight trains. With an increase in weight of less than two per cent as compared with the heaviest Mikados in service on the Michigan Central, No. 8000 has an increase of nearly eight per cent in tractive power derived from the forward cylinders and an increase of over 26 per cent when the booster is cut in.

The designers of this locomotive in addition to securing the greatest possible tractive effort with a minimum weight at which strength would not be sacrificed, incorporated the best known practices and devices for securing economy in the use of fuel and water. A type E superheater has been applied which produces a higher temperature of steam than the superheaters in general use.

On Locomotive 8000 a maximum tractive effort of 74,500 lb. is obtainable. Of this figure 11,000 lb. are delivered by the booster, the remaining 63,500 lb. being obtained from the main cylinders.

Refinements in design and the use of alloy of steel and hollow axles and crank-pins have made it possible to eliminate a great amount of weight ordinarily necessary. The

weight of the locomotive, exclusive of tender, is 334,000 lb. The tender, which has a capacity of 10,000 gallons of water and 16 tons of coal, weighs 199.700 lb. The boiler carries 200 lb. per square inch steam pressure. The main cylinders are 28 in. in diameter, with 30 in. stroke. The diameter of the driving wheels is 63 in.

On this locomotive for the first time superheated steam is used to operate the air pump, feed-water pump, booster engine and headlight turbo-generator.

The locomotive is equipped with the Superheater Company's feed-water heater. The heater is located at the front of the engine, above the headlight and near the top of the boiler, on a level above the top of the tank so as to give the condensate pipe line plenty of fall to return the condensed water to the filter on the rear of the tender. The feed-water pump is mounted on the left side of the boiler back of the smokebox.

Another important departure from standard railway practice is the feature of superheating the steam before it reaches the main throttle. In locomotive 8000 the steam from the boiler passes through the steam dome into the dry pipe and thence to the superheater units, the dry pipe, which is outside of the boiler, being connected at the forward end direct to the superheater.

Before the steam leaves the dome it is passed through a separator which collects any water that may be carried in the steam, the water being automatically returned to the boiler, which, together with the taking of steam from the highest possible point of boiler, insures absolutely dry steam. From the superheated steam passages in the header, the superheated steam is conveyed to the throttle, located in a throttle box, at the top of the smoke-box and just forward of the stack, another unusual departure from existing designs and practice which was necessary in order to permit the use of superheated steam for the auxiliaries.

Careful attention has been given to the application of devices to facilitate handling the locomotive by the enginemen, the special equipment consisting of the precision power reverse gear, an Elvin stoker and a power grate shaker. The interior arrangement of the cab is such that the engineer and fireman perform the necessary duties in connection with the operation of the engine with minimum of movement from their positions on either side of the cab, the physical effort of each being practically nil. Even the blowing of the whistle is pneumatically controlled, an air valve being located near the side of the cab and immediately in front of the engineer.

As is customary on the Michigan Central, the engine is equipped with a water scoop, which eliminates stops and consequent delays for taking water.

Before being put into service the engine was inspected by President Smith, Vice-President E. D. Bronner and General Manager Henry Shearer of the Michigan Central.

Locomotive 8000 has more than lived up to expectations in the short time it has been in service. When it has been in service a sufficient length of time dynamometer tests will be taken and results very definitely determined.

The Calculation of Elliptic Springs

Formulas and Tables for the Rapid Determination of Capacity and Deflexion

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In order to facilitate the calculation of capacity and deflection of elliptic and semi-elliptic springs in railroad work, the formulas herewith given have been reduced to their simplest form. These formulas are supplemented by tables in order to make quick work of calculations of this type of springs. No attempt will be made to derive or prove the authenticity of the formulas except in an elementary way.

All elliptic springs are calculated as semi-elliptic, the capacity being the same and the deflection double that of a semi-elliptic spring.

The following symbols are used in the formulas:

M = Bending moment.

P = Safe working load at center of one plate at fiber stress of 80,000 lb. per sq. in.

l = Length of span of spring.

I = Moment of inertia of a rectangular section (each plate).

S = Unit stress, 80,000 lb. per sq. in.

c = Distance between center of gravity and extreme fibre of a section of a plate.

b = Width of plate.

h = Thickness of plate.

n = Number of plates.

W = Total capacity of spring.

f = Deflection.

p = Load on one end of spring.

$L = \text{Half of span} = \frac{l}{2}$

E = Modulus of elasticity = 30,000,000.

K = Constant (See formula 3).

Capacity

For calculating capacity, a semi-elliptic spring may be taken as a simple beam supported at both ends with a concentrated load at the center. Assuming the spring to consist of one plate, the bending moment at the center is

$$M = \frac{P\,l}{4} = \frac{S\,I}{c}$$

which is the standard formula for this type of beam. Substituting the following

$$I = \frac{b\,h^3}{12},\ c = \frac{h}{2} \text{ and } S = 80{,}000$$

the formula becomes $\frac{P\,l}{4} = \frac{80{,}000\,b\,h^3}{6\,h}$

and solving $P = \frac{80{,}000 \times 4 \times b\,h^2}{6\,l} = \frac{53{,}333\,b\,h^2}{l}$

which is the capacity of one plate.

Assuming (b = 1 in.) the formula becomes

$$P = \frac{53{,}333\,h^2}{l} \qquad \text{.......... (1)}$$

This is the standard formula for the capacity of one plate, one inch wide. Then the total capacity of the spring is

$$W = P\,b\,n \qquad \text{.......... (2)}$$

Values of "P" are given in Table I, calculated by means of formula (1).

Example 1.—Required the capacity of a semi-elliptic spring having fourteen 5-in. by ½-in. plates, 36-in. span.

In Table I, in column for ½-in. plates and line for 36-in. span we find value of P = 372. Then

$$W = P\,b\,n = 372 \times 5 \times 14 = 26{,}040 \text{ lb.}$$

A full elliptic spring composed of two of these semi-elliptic springs would have the same capacity, i. e., 26,040 lb.

Deflection

Though a semi-elliptic spring is considered as a simple beam supported at each end with a concentrated load at the center for calculating the capacity, the same does not hold true for the deflection.

From experiments it has been determined that the deflection follows the formula for a cantilever beam of uniform strength which is

$$f = \frac{6\,p\,L^3}{E\,n\,b\,h^3}$$

This holds true when all the plates are evenly graduated and there is only one plate of the full length of the spring.

However, in railroad work, it is customary to make one-fourth of the number of plates of full length, in which case the formula has been reduced by experiments to

$$f = \frac{5.44\ p\ L^3}{E\ n\ b\ h^3}$$

(Kent's Mechanical Engineer's Handbook, 9th Edition, page 417)

$$\text{or} \qquad f = \frac{5.44\ p\ l^3}{8\,E\,n\,b\,h^3}$$

$$\text{Substituting} \qquad E = 30{,}000{,}000 \text{ and } p = \frac{P}{2}$$

$$f = \frac{.000{,}000{,}011{,}34\ P\ l^3}{n\,b\,h^3}$$

Analyzing this formula, it will be seen that for any one plate and span the deflection varies in direct proportion to the load and inversely with the number of plates. In order to simplify calculations, this deflection formula has been divided into two factors, as follows:

$$f = \frac{.000{,}000{,}011{,}34\ l^3}{b\,h^3} \times \frac{P}{n}$$

The first factor is constant for the same plate and span, and for simplifying the formula it has been designated as "K," hence

$$K = \frac{.000{,}000{,}011{,}34\ l^3}{b\,h^3} \ldots\ldots (3)$$

$$\text{and} \qquad f = \frac{K\ P}{n} \ldots\ldots\ldots (4)$$

Values of "K" are given in Table 2 on page 440.

The deflection added to the working height gives the free height of the spring.

Example 2.—Find the deflection of spring given in Example 1 when loaded to 24,000 lb.

In Table 2, in column under 5-in. by ½-in. plate and line for 36-in. span, we find K = .00084, then

$$f = \frac{K\ P}{n} = \frac{.00084 \times 24000}{14} = 1.442\text{-in., say } 1\ 7/16\text{-in.}$$

Should this spring be loaded to capacity, 26,040 lb., the deflection under this load may be found in Table 1 in column under ½-in. plate and line for 36-in. span, namely 1.58 in.

A full elliptic spring composed of two semi-elliptic springs as mentioned in Example 2, would have twice the deflection of one semi-elliptic spring, or 2⅞ in.

In Tables 1 and 2, figures above the upper heavy line and below the lower heavy line are not considered safe and springs of those dimensions should be avoided.

If springs are desired with stresses other than 80,000 lb. per sq. in., for which the tables have been worked up, the capacity and deflection may be worked up by above method and tables and multiply the answer by the ratio of the stress desired to 80,000 lb.

Example 3.—Same spring as Example 1, only capacity wanted at 90,000 lb.

Capacity at 80,000 lb. stress = 26,040 lb.

$$\text{Capacity at } 90{,}000 \text{ lb. stress} = 26{,}040 \times \frac{90{,}000}{80{,}000} = 29{,}295 \text{ lb}$$

The deflection of this spring with capacity load would be

$$f = 1.58 \times \frac{90{,}000}{80{,}000} = 1.78 \text{ in.}$$

The above formulas and tables only apply to carbon steel springs and will not give correct answers for springs made from special alloy steels.

TABLE I—SEMI-ELLIPTIC SPRINGS—VALUES OF "P" AND DEFLECTIONS UNDER CAPACITY LOAD

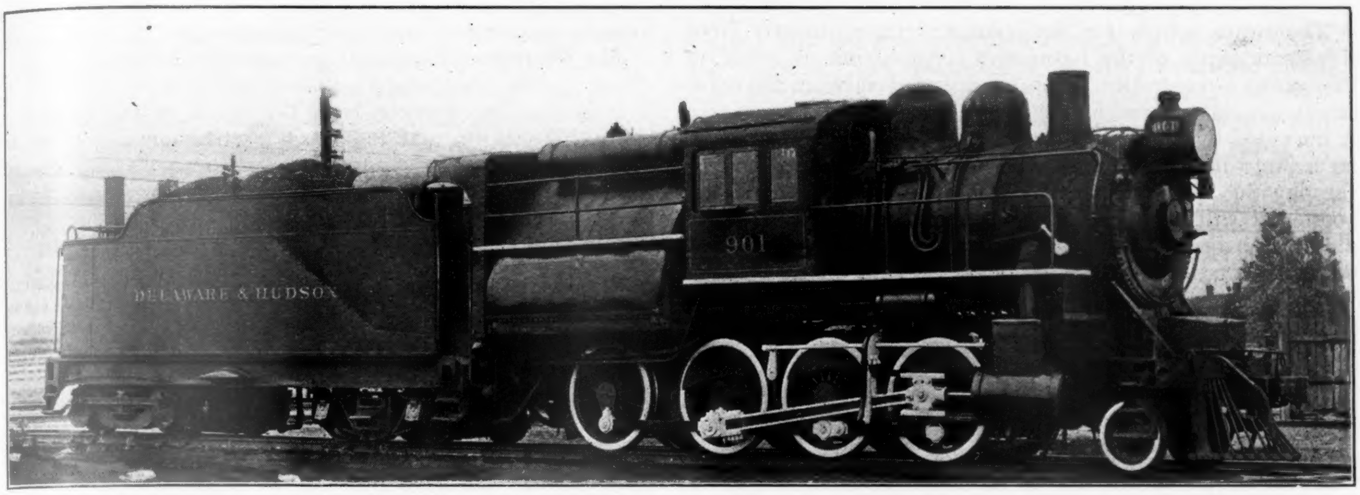
Length Between Centers	One Plate 1 Inch Wide — ¼ in.		5/16 in.		11/32 in.		⅜ in.		13/32 in.		7/16 in.		15/32 in.		½ in.		17/32 in.		9/16 in.		⅝ in.	
	Load	Defl.	Load	Defl.	Load	Defl.	Load	Defl.	Load	Defl.	Load	Defl.	Load	Defl.	Load	Defl.	Load	Defl.	Load	Defl.	Load	Defl.
20	167	.98	260	.78	315	.71	375	.65	442	.60	510	.56	587	.52	667	.49	757	.46	844	.44	1,042	.39
22	152	1.19	235	.95	286	.86	341	.79	403	.73	464	.67	534	.63	606	.59	687	.56	767	.53	947	.47
24	139	1.41	217	1.13	263	1.03	312	.94	368	.86	425	.80	488	.75	556	.71	632	.66	703	.63	868	.56
26	128	1.66	200	1.32	243	1.21	288	1.10	340	1.00	393	.95	452	.89	513	.83	583	.78	649	.74	801	.66
28	119	1.92	186	1.53	225	1.40	268	1.28	316	1.18	365	1.10	419	1.02	476	.96	541	.90	602	.85	744	.76
29	115	2.05	180	1.65	217	1.50	259	1.37	305	1.26	352	1.18	405	1.10	460	1.03	523	.97	582	.92	719	.82
30	111	2.20	173	1.76	210	1.60	250	1.47	295	1.35	341	1.26	391	1.17	444	1.10	505	1.04	562	.98	694	.88
32	104	2.50	163	2.00	197	1.82	234	1.67	276	1.54	319	1.43	367	1.34	416	1.25	474	1.18	527	1.11	651	1.00
33	101	2.66	159	2.13	191	1.94	228	1.78	268	1.64	311	1.52	355	1.42	405	1.33	459	1.25	514	1.18	633	1.06
34	98	2.83	153	2.26	185	2.06	220	1.88	260	1.74	301	1.62	345	1.51	392	1.41	446	1.33	496	1.26	613	1.13
35	95	3.00	149	2.40	180	2.18	215	2.00	253	1.84	293	1.71	335	1.60	381	1.50	433	1.41	485	1.33	597	1.20
36	92	3.17	144	2.53	175	2.31	208	2.12	246	1.95	284	1.81	326	1.69	372	1.58	421	1.49	469	1.41	579	1.27
38	88	3.53	137	2.78	166	2.57	197	2.35	233	2.17	269	2.03	309	1.89	350	1.76	399	1.66	444	1.56	548	1.41
39	85	3.72	134	2.98	162	2.71	193	2.48	227	2.29	263	2.13	301	1.99	343	1.86	389	1.75	436	1.65	536	1.49
40	83	3.92	130	3.13	158	2.85	187	2.60	221	2.41	255	2.24	293	2.09	333	1.95	379	1.84	421	1.73	521	1.56
42	79	4.32	124	3.45	150	3.14	178	2.87	211	2.65	243	2.47	280	2.31	317	2.16	361	2.03	401	1.91	496	1.73
43	78	4.50	122	3.62	147	3.29	175	3.02	206	2.78	238	2.58	273	2.41	311	2.26	352	2.12	395	2.01	487	1.81
44	76	4.74	118	3.79	143	3.45	170	3.15	201	2.91	232	2.71	267	2.53	303	2.37	345	2.22	383	2.10	473	1.89
46	72	5.18	113	4.14	137	3.76	163	3.45	192	3.18	222	2.96	255	2.76	290	2.58	330	2.43	366	2.29	453	2.07
48	69	5.65	109	4.51	131	4.11	156	3.75	184	3.46	213	3.22	245	3.01	277	2.82	315	2.65	351	2.50	434	2.25
49	68	5.89	107	4.69	129	4.28	153	3.91	181	3.61	209	3.36	240	3.13	273	2.94	309	2.76	346	2.61	427	2.34
50	66	6.12	104	4.89	126	4.45	150	4.07	177	3.76	204	3.49	235	3.26	266	3.06	303	2.88	337	2.71	416	2.44
52	64	6.62	100	5.28	121	4.82	144	4.40	170	4.06	197	3.78	226	3.52	256	3.30	291	3.10	324	2.93	400	2.64
54	62	7.12	97	5.70	117	5.19	139	4.75	164	4.39	189	4.08	217	3.81	247	3.57	281	3.36	312	3.16	385	2.85
56	59	7.66	93	6.14	113	5.58	134	5.11	158	4.71	182	4.38	210	4.09	238	3.83	271	3.60	301	3.40	372	3.06
58	57	8.24	90	6.60	109	6.00	129	5.50	153	5.05	176	4.71	202	4.40	230	4.12	261	3.87	291	3.65	359	3.28
60	55	8.80	87	7.05	105	6.31	125	5.87	147	5.41	170	5.04	196	4.70	222	4.40	253	4.14	281	3.91	347	3.52
62	54	9.40	84	7.53	102	6.85	121	6.26	143	5.79	165	5.37	189	5.02	215	4.70	245	4.42	272	4.18	336	3.75
64	52	10.00	81	8.00	98	7.29	117	6.68	138	6.15	160	5.72	183	5.35	208	5.00	237	4.70	264	4.45	325	4.00
66	50	10.69	79	8.52	96	7.76	114	1.09	134	6.55	155	6.09	178	5.69	202	5.32	230	5.00	256	4.74	315	4.25
68	49	11.31	77	9.05	93	8.24	112	7.53	130	6.95	150	6.45	173	6.04	196	5.65	223	5.31	248	5.02	306	4.52

TABLE II—SEMI-ELLIPTIC SPRINGS—CONSTANTS FOR FIGURING DEFLECTIONS—VALUES OF "K"

Length between centers	2½ in. by 11/32 in.	3 in. by ¼ in.	3 in. by 5/16 in.	3 in. by 11/32 in.	3 in. by 3/8 in.	3 in. by 7/16 in.	3 in. by ½ in.	3¼ in. by 5/16 in.	3¼ in. by 11/32 in.	3¼ in. by 3/8 in.	3¼ in. by 7/16 in.	3¼ in. by ½ in.	Length between centers
20	.00089	.00024	.00096	.00074	.00057	.00036	.00024	.00091	.00068	.00053	.00033	.00022	20
22	.00118	.00025	.00131	.00098	.00076	.00048	.00032	.00121	.00091	.00070	.00044	.00030	22
24	.00154	.00033	.00171	.00128	.00099	.00062	.00041	.00157	.00118	.00091	.00057	.00038	24
26	.00195	.00042	.00216	.00163	.00125	.00079	.00053	.00200	.00150	.00116	.00073	.00049	26
28	.00244	.00053	.00270	.00203	.00156	.00099	.00066	.00250	.00187	.00145	.00091	.00061	28
29	.00271	.00059	.00301	.00226	.00174	.00109	.00073	.00277	.00208	.00160	.00101	.00068	29
30	.00301	.00065	.00331	.00250	.00193	.00121	.00081	.00307	.00230	.00178	.00112	.00075	30
32	.00365	.00079	.00404	.00303	.00234	.00147	.00098	.00372	.00279	.00216	.00136	.00091	32
33	.00399	.00086	.00443	.00332	.00256	.00161	.00108	.00408	.00306	.00236	.00149	.00100	33
34	.00438	.00095	.00485	.00364	.00291	.00177	.00118	.00447	.00335	.00259	.00163	.00109	34
35	.00476	.00103	.00528	.00398	.00306	.00192	.00129	.00486	.00365	.00282	.00177	.00119	35
36	.00519	.00112	.00576	.00434	.00333	.00210	.00140	.00531	.00398	.00307	.00193	.00129	36
38	.00610	.00132	.00675	.00507	.00392	.00246	.00164	.00624	.00467	.00361	.00227	.00152	38
39	.00660	.00143	.00730	.00548	.00424	.00266	.00178	.00675	.00505	.00390	.00246	.00164	39
40	.00712	.00154	.00789	.00592	.00457	.00282	.00192	.00727	.00546	.00422	.00265	.00177	40
42	.00825	.00179	.00911	.00688	.00529	.00333	.00222	.00842	.00632	.00488	.00307	.00206	42
43	.00883	.00189	.00980	.00735	.00568	.00357	.00238	.00904	.00678	.00524	.00329	.00221	43
44	.00948	.00205	.01050	.00790	.00609	.00383	.00256	.00970	.00726	.00561	.00353	.00236	44
46	.01080	.00232	.01200	.00910	.00695	.00437	.00292	.01108	.00830	.00640	.00404	.00261	46
48	.01231	.00266	.01361	.01025	.00790	.00497	.00332	.01258	.00944	.00728	.00458	.00306	48
49	.01370	.00283	.01450	.01088	.00840	.00528	.00352	.01338	.01000	.00774	.00487	.00327	49
50	.01390	.00301	.01540	.01159	.00894	.00562	.00375	.01421	.01068	.00823	.00518	.00347	50
52	.01563	.00338	.01730	.01304	.01004	.00631	.00422	.01600	.01200	.00925	.00584	.00390	52
54	.01752	.00379	.01941	.01460	.01124	.00706	.00472	.01791	.01343	.01039	.00653	.00436	54
56	.01951	.00422	.02160	.01630	.01252	.00789	.00527	.01996	.01499	.01156	.00728	.00487	56
58	.02173	.00470	.02410	.01810	.01396	.00878	.00585	.02220	.01668	.01287	.00809	.00541	58
60	.02400	.00520	.02660	.02010	.01542	.00970	.00648	,02459	.01842	.01421	.00895	.00599	60
62	.02660	.00575	.02880	.02213	.01703	.01071	.00715	.02715	.02035	.01570	.00990	.00660	62
64	.02820	.00633	.03237	.02430	.01872	.01178	.00786	.02982	.02236	.01723	.01088	.00726	64
66	.03200	.00691	.03540	.02661	.02054	.01290	.00862	.03270	.02450	.01890	.01191	.00797	66
68	.03500	.00758	.03880	.02920	.02246	.01412	.00945	.03580	.02684	.02073	.01306	.00872	68

Length between centers	3½ in. by 5/16 in.	3½ in. by 11/32 in.	3½ in. by 3/8 in.	3½ in. by 7/16 in.	3½ in. by ½ in.	4 in. by 5/16 in.	4 in. by 11/32 in.	4 in. by 3/8 in.	4 in. by 13/32 in.	4 in. by 7/16 in.	4 in. by 15/32 in.	4 in. by ½ in.	Length between centers
20	.00088	.00063	.00049	.00031	.00021	.00074	.00056	.00043	.00037	.00027	.00022	.00018	20
22	.00113	.00084	.00065	.00041	.00027	.00099	.00074	.00057	.00049	.00036	.00029	.00024	22
24	.00146	.00110	.00085	.00053	.00036	.00128	.00096	.00074	.00064	.00047	.00038	.00031	24
26	.00185	.00139	.00107	.00068	.00045	.00162	.00122	.00094	.00081	.00059	.00048	.00039	26
28	.00232	.00174	.00134	.00085	.00057	.00203	.00152	.00118	.00102	.00074	.00060	.00049	28
29	.00257	.00193	.00149	.00094	.00063	.00225	.00169	.00131	.00112	.00082	.00067	.00054	29
30	.00285	.00214	.00165	.00104	.00070	.00250	.00187	.00145	.00125	.00091	.00074	.00061	30
32	.00345	.00260	.00200	.00126	.00084	.00303	.00227	.00175	.00152	.00110	.00090	.00074	32
33	.00379	.00285	.00219	.00138	.00092	.00332	.00249	.00192	.00166	.00121	.00099	.00081	33
34	.00415	.00312	.00240	.00157	.00103	.00364	.00273	.00211	.00182	.00132	.00108	.00089	34
35	.00452	.00340	.00262	.00165	.00111	.00397	.00297	.00229	.00198	.00144	.00118	.00097	35
36	.00492	.00370	.00285	.00179	.00120	.00432	.00324	.00250	.00216	.00157	.00128	.00105	36
38	.00578	.00435	.00335	.00211	.00142	.00507	.00380	.00293	.00254	.00184	.00151	.00123	38
39	.00626	.00470	.00362	.00228	.00153	.00549	.00412	.00317	.00274	.00199	.00163	.00134	39
40	.00675	.00507	.00391	.00246	.00165	.00592	.00444	.00342	.00296	.00215	.00175	.00144	40
42	.00783	.00588	.00453	.00285	.00191	.00686	.00514	.00397	.00342	.00249	.00203	.00167	42
43	.00840	.00630	.00486	.00306	.00205	.00735	.00552	.00427	.00368	.00268	.00218	.00179	43
44	.00900	.00675	.00520	.00328	.00219	.00788	.00591	.00456	.00394	.00286	.00234	.00192	44
46	.01028	.00771	.00594	.00374	.00251	.00900	.00675	.00521	.00450	.00327	.00267	.00220	46
48	.01168	.00876	.00675	.00425	.00285	.01022	.00767	.00592	.00512	.00372	.00303	.00249	48
49	.01241	.00932	.00718	.00452	.00303	.01089	.00815	.00630	.00545	.00396	.00323	.00265	49
50	.01320	.00991	.00765	.00480	.00322	.01158	.00867	.00670	.00579	.00421	.00343	.00282	50
52	.01485	.01114	.00860	.00540	.00363	.01302	.00975	.00753	.00651	.00474	.00386	.00317	52
54	.01665	.01249	.00962	.00605	.00406	.01458	.01093	.00844	.00730	.00530	.00432	.00355	54
56	.01855	.01391	.01072	.00675	.00454	.01626	.01220	.00940	.00815	.00590	.00482	.00396	56
58	.02060	.01548	.01192	.00750	.00504	.01807	.01353	.01047	.00904	.00656	.00535	.00440	58
60	.02280	.01712	.01320	.00830	.00558	.02000	.01500	.01158	.01000	.00727	.00594	.00487	60
62	.02500	.01891	.01458	.00915	.00615	.02207	.01652	.01280	.01102	.00802	.00655	.00538	62
64	.02763	.02080	.01600	.01010	.00675	.02426	.01820	.01406	.01212	.00882	.00719	.00591	64
66	.03036	.02280	.01757	.01104	.00741	.02660	.01996	.01540	.01330	.00968	.00789	.00648	66
68	.03321	.02495	.01920	.01210	.00812	.02910	.02182	.01684	.01456	.01060	.00865	.00710	68

Length between centers	4 in. by 17/32 in.	4½ in. by 5/16 in.	4½ in. by 3/8 in.	4½ in. by 7/16 in.	4½ in. by ½ in.	5 in. by 3/8 in.	5 in. by 7/16 in.	5 in. by ½ in.	6 in. by 5/16 in.	6 in. by 3/8 in.	6 in. by 7/16 in.	6 in. by ½ in.	Length between centers
20	.00015	.00066	.00038	.00024	.00016	.00034	.00021	.00014	.00049	.00028	.00017	.00012	20
22	.00020	.00087	.00051	.00032	.00021	.00045	.00028	.00019	.00066	.00038	.00023	.00016	22
24	.00026	.00114	.00065	.00041	.00027	.00059	.00037	.00025	.00085	.00049	.00031	.00020	24
26	.00033	.00144	.00083	.00052	.00035	.00075	.00047	.00031	.00108	.00062	.00039	.00026	26
28	.00041	.00180	.00104	.00065	.00043	.00094	.00059	.00039	.00135	.00078	.00049	.00033	28
29	.00046	.00199	.00116	.00073	.00049	.00102	.00066	.00044	.00150	.00086	.00054	.00037	29
30	.00051	.00222	.00128	.00081	.00054	.00115	.00072	.00049	.00166	.00096	.00060	.00040	30
32	.00062	.00268	.00156	.00098	.00066	.00140	.00088	.00059	.00202	.00115	.00073	.00049	32
33	.00068	.00295	.00171	.00107	.00072	.00154	.00097	.00065	.00221	.00128	.00081	.00054	33
34	.00074	.00322	.00187	.00118	.00078	.00168	.00105	.00071	.00242	.00141	.00091	.00059	34
35	.00081	.00351	.00203	.00128	.00086	.00184	.00115	.00077	.00264	.00153	.00096	.00064	35
36	.00088	.00383	.00222	.00139	.00093	.00199	.00126	.00084	.00288	.00166	.00104	.00070	36
38	.00104	.00449	.00260	.00164	.00110	.00234	.00147	.00096	.00338	.00195	.00123	.00082	38
39	.00112	.00486	.00282	.00178	.00119	.00254	.00159	.00107	.00366	.00212	.00133	.00089	39
40	.00121	.00525	.00304	.00192	.00128	.00272	.00172	.00115	.00394	.00228	.00143	.00096	40
42	.00140	.00608	.00352	.00222	.00147	.00317	.00199	.00134	.00456	.00264	.00166	.00111	42
43	.00150	.00652	.00378	.00238	.00159	.00341	.00214	.00144	.00490	.00284	.00178	.00119	43
44	.00161	.00699	.00405	.00255	.00170	.00364	.00229	.00154	.00525	.00304	.00191	.00128	44
46	.00183	.00798	.00462	.00280	.00194	.00415	.00262	.00175	.00600	.00346	.00218	.00146	46
48	.00208	.00906	.00526	.00330	.00220	.00473	.00298	.00199	.00681	.00385	.00248	.00166	48
49	.00222	.00965	.00559	.00352	.00236	.00504	.00317	.00212	.00725	.00420	.00264	.00177	49
50	.00236	.01025	.00595	.00374	.00250	.00535	.00336	.00225	.00771	.00446	.00280	.00187	50
52	.00265	.01152	.00668	.00420	.00281	.00602	.00377	.00253	.00866	.00501	.00314	.00211	52
54	.00296	.01291	.00749	.00470	.00316	.00673	.00424	.00284	.00972	.00563	.00353	.00236	54
56	.00331	.01440	.00835	.00525	.00351	.00750	.00474	.00319	.01081	.00625	.00394	.00264	56
58	.00368	.01602	.00928	.00584	.00391	.00830	.00526	.00352	.01203	.00695	.00437	.00293	58
60	.00407	.01771	.01028	.00645	.00432	.00921	.00581	.00389	.01330	.00770	.00485	.00324	60
62	.00450	.01960	.01132	.00713	.00463	.01021	.00641	.00430	.01470	.00851	.00534	.00327	62
64	.00492	.02148	.01242	.00782	.00525	.01120	.00705	.00473	.01615	.00935	.00588	.00395	64
66	.00541	.02360	.01363	.00860	.00575	.01228	.00772	.00517	.01770	.01022	.00645	.00432	66
68	.00594	.02582	.01492	.00938	.00631	.01346	.00846	.00567	.01940	.01121	.00705	.00473	68



Superheated Consolidation Locomotive to Which the Tender Booster Has Been Applied

Booster for Tender Trucks Developed on D. & H.

Utilizing Tender to Increase Tractive Power Enables Locomotives to Haul Heavier Trains

DURING the past two years there has been developed on the Delaware & Hudson a booster designed for application on the tender trucks. The basic principles underlying this development were: First, to utilize as a source of revenue tractive power at moderate speed the

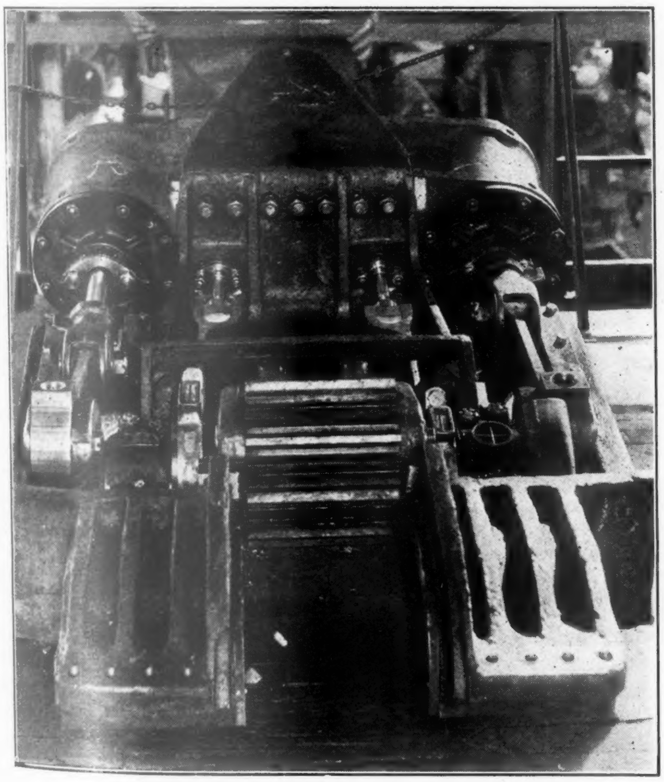


Fig. 1—Booster Engine Assembled in Shop

excess boiler capacity, the volume of which is increased materially by the use of superheated steam. Second, to convert the tender weight, unused as a motive agent, into a means of obtaining additional tractive power, the amount of increase depending on the speed and whether the application is made on one or both tender trucks. Third, to obtain more nearly constant tractive force at the tender draw bar during successive revolutions of the locomotive. The development of the tender truck booster has now progressed sufficiently to prove that these objectives have been attained.

The tender booster, which has been patented jointly by J. A. McGrew, general superintendent of equipment and way and J. T. Loree, general manager, comprises a four-wheel truck fitted with side rods and a reciprocating steam engine, arranged to drive one of the axles. The engine which supplies the motive force for the booster is shown in Fig. 1.

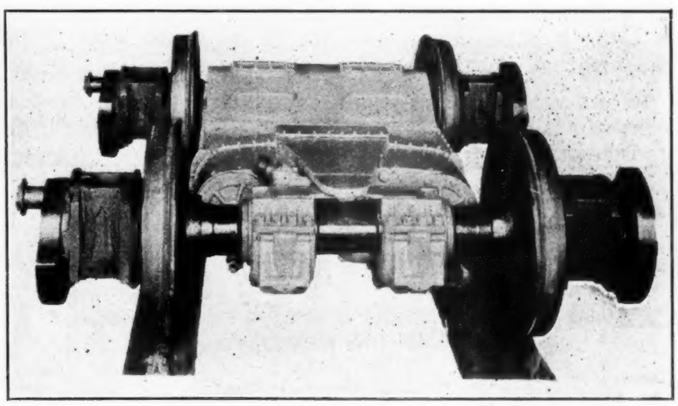


Fig. 2—Booster Truck Before Frame Has Been Applied

It is a simple two cylinder engine with 10-in. by 10-in. cylinders. On the main shaft of the booster engine is a pinion and on one of the tender truck axles is a large gear. Intermediate between them is a gear arranged to be thrown into mesh between the pinion and the large gear by a bell crank operated by a piston impelled by the superheated steam forming the motive agent for operating the booster cylinders. In Fig. 2 the engine is shown mounted on the axles before the frame has been put in place. The two bearings shown in the foreground of Fig. 1 span the geared axle and the opposite end of the frame casting rests on springs supported by journal boxes on the other axle, giving a three point support. A view of the completed truck as applied under the tender is shown in Fig. 3.

The steam supply for the booster is taken directly from the steam pipes of the locomotive. Admission of steam to the booster is controlled by an air-operated valve in the main steam line, as shown in Fig. 4. Operation of the booster is governed by an independent air valve in the cab, thus in no manner interfering with the engineman in his method of running the locomotive, enabling him to use or cut out the booster at will as road conditions may indicate to be desirable. The booster cannot be started except when the main throttle is open and if the locomotive is shut off the booster

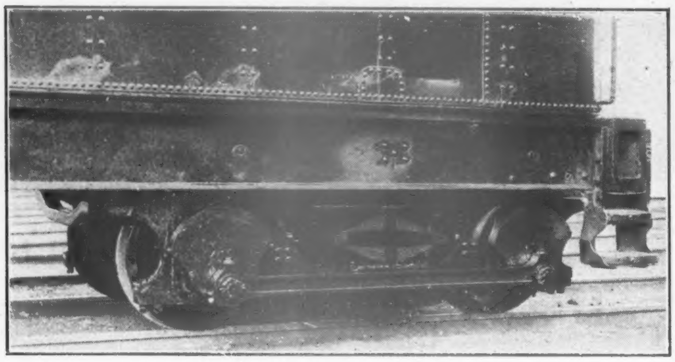


Fig. 3—Completed Truck as Applied Under Tender

is automatically thrown out of gear. Barco joints are fitted in the steam pipe between the locomotive and the tender to give the necessary flexibility at this point.

The steam on its way to the engine entrains the booster engine transmission gears. The fact that superheated steam in the locomotive steam pipe is simultaneously the motive agent of the booster and the controlling power effecting the meshing of the gears, produces practically perfect synchronization of effort of the locomotive and booster engines and also provides an elastic cushion for disengagement should excessive stresses be set up within the gears. The steam from the booster is exhausted direct, without pipe couplings, into a simple feed water heater located in the tender tank. The gear ratio between the booster engine shaft and the tender axle is 1 to 4.25, and the wheels are 33 in. in diameter. The rated tractive effort with 210 lb. steam pressure, based on the formula commonly used for locomotives, is 12,200 lb.

The locomotive to which the booster has been applied is shown in the photograph at the beginning of this article. It is of the Consolidation type, the weight of the locomotive being 207,150 lb. and the rated tractive power 42,100 lb.

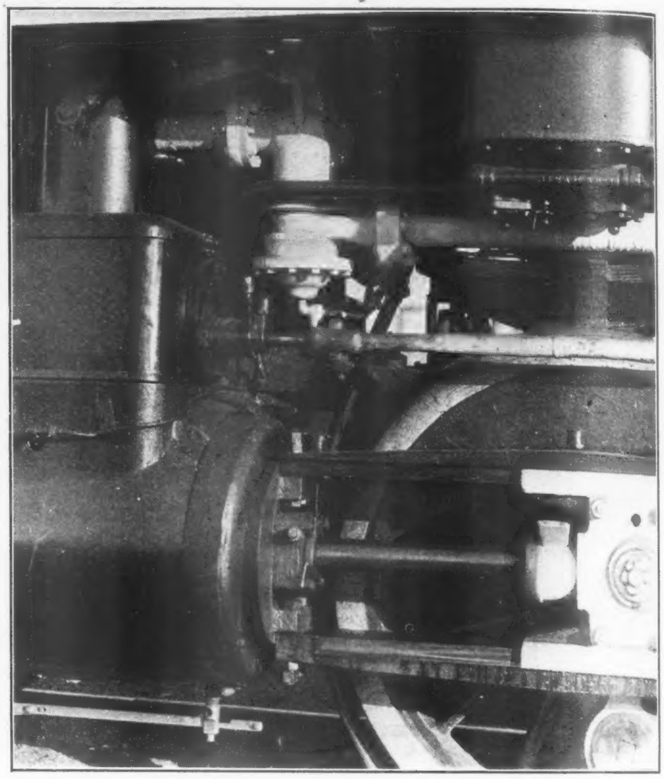


Fig. 4—Steam Pipe to Booster and Air Operated Valve

developing a maximum draw bar pull of 36,000 lb. on level track. The weight of the tender when empty is 58,800 and when loaded 120,800 lb.

To determine the results that can be obtained in actual service from locomotives equipped with the booster, tests

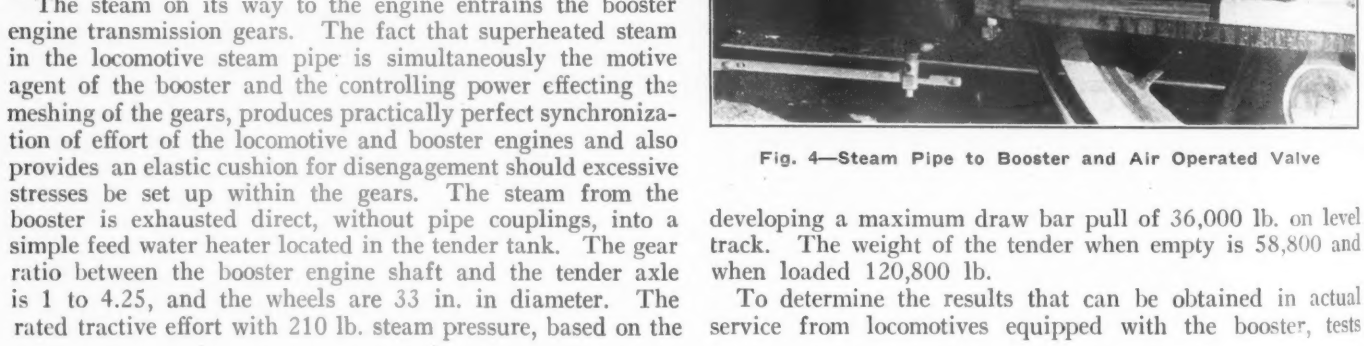


Fig. 5—Dynamometer Chart Showing Operation of Booster on a Ruling Grade

were made over the Pennsylvania, Susquehanna and Champlain divisions. A photograph taken from the dynamometer chart on the controlling grade on the Champlain division is shown in Fig. 5. The increase in tractive power due to the booster is clearly shown in the draw bar pull curve. The standard rating for this class of locomotive, without the booster, on this division is 1,650 adjusted tons, while the tonnage of the test train was 2,477 adjusted tons in 51 cars, an increase of 48 per cent.

An analysis of the various tests conducted with the booster developed the following principles:

When superheated steam is used as the motive agent in the booster, and advantage is taken of the opportunity thus afforded for using steam expansively in the locomotive cylinders, no difficulty is experienced in maintaining practically constant steam pressure.

The use of steam for the gear operating cylinders as well as for supplying power to the locomotive and booster

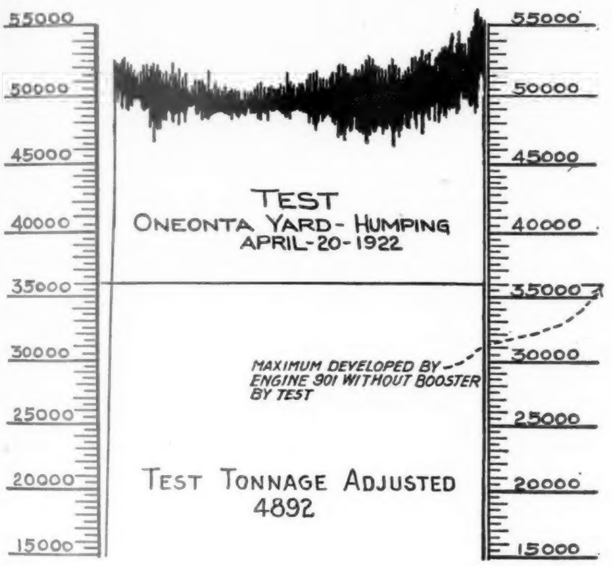


Fig. 6—Chart of Tractive Effort of Locomotive with Booster Pushing Over a Hump

cylinders, gives a complete synchronization of effort between the primary and secondary engines.

The results of the tests also clearly demonstrate the following operating advantages resulting from the booster application:

The tonnage which the locomotive can haul is increased; abnormal stresses on draft gears and equipment are decreased, and more prompt and constant acceleration is effected. Tire wear and rail wear, due to slipping of the locomotive driving wheels, are decreased. The average speed over grades is increased and grades may be equalized without a very heavy capital expenditure. The booster makes it possible to haul increased tonnage over divisions where the trainload is now limited by the weight of locomotives which the bridges can safely carry. The location of the booster is such that no delay in turning of power need be occasioned by repairs. The addition of the geared power unit on the tender permits of using a lower factor of adhesion in locomotive design. The booster also effects a saving in fuel by reducing the time required for movement over the division, and by making it possible for a smaller locomotive to do the work of a larger type.

The Central Railway Club, Buffalo, owing to the current labor troubles, has postponed until further notice its outing scheduled to take place on the last Thursday in August. The next regular meeting will be held on September 14, at 8 p. m. (standard time) at the Hotel Iroquois.

Locomotive Feed Water Heaters*

In order that definite information might be obtained as to the operation and maintenance of the Locomotive Feed Water Heaters, a questionnaire was compiled and sent to the presidents of 137 railroads in the United States and Canada. Answers were received from 78 of these roads, 20 roads having feed water heaters.

In 1920 there were seven roads using feed water heaters. There are now 28 American roads with five types of heaters on order or in service. The number of the different types of heaters in use or on order are as follows:

The Superheater Company's feed water heater	93
Worthington feed water heater	136
Weir feed water heater	1
Simplex-Blake-Knowles feed water heater	3
Local type	1
Total heaters applied or on order	234

The advisability of extending the use of locomotive feed water heaters is strongly recommended by five railroads; the other roads consider that the process of development is yet in the experimental stage and are waiting until further tests show that the economy derived will justify their use.

The application of feed water heaters has not been limited to any single class of power or service. The largest locomotive equipped with a feed water heater is a Mallet type of 107,961 lb. tractive effort, while the smallest is an American type of 24,000 lb. tractive effort. Other types of locomotives to which feed water heaters have been applied are Mikado, Pacific, Consolidation, Mountain and locomotives in suburban service. These locomotives operate in both passenger and freight service on mountainous and rolling territory. Both coal and oil are used for fuel.

One of the most important considerations in the selection of the type of feed water heater to be used, is the character of the water in the territory through which the locomotive is to operate. In bad water districts, the open type heater seems to be preferred, as the scale deposits on the tubes of the closed type heater retard the heat transmitted and reduce the efficiency of the heater, and there would be less danger of boiler trouble from oil due to the frequent washouts. No road has reported trouble from oil from the feed water in the boiler. Roads where the boiler washout period averages 30 days generally prefer the closed type of feed water heater.

Three roads have reduced the size of the exhaust nozzles on application of feed water heaters and one road has enlarged the nozzle. The reduction in the size of the nozzle is done in order to offset the loss in superheat temperature which occurs when a feed water heater is applied to a locomotive. This is not considered advisable, as the reduction of the size of the nozzle increases the back pressure, which will probably offset any saving that would be effected by the increased superheat.

There has been no difference reported in the amount of boiler scale in boilers equipped with feed water heaters over the other engines.

The open type heater has in all cases gone from shopping to shopping without cleaning, regardless of the water conditions. While going through the shop the scale deposit is scraped from the inside of the heater, no acid or cleaning solution being used.

In good water territory, the closed type of heater is cleaned each time the locomotive is shopped. The usual method of doing this is to dip the tube nest into a lye vat to remove any oily deposit which may have formed on the outside of the tubes. In districts where the water conditions necessitate more frequent cleaning, the deposit is either washed out by flushing the heater with water or, if the scale is not soluble, a dilute solution of muriatic acid is pumped through the heater for a short time and then water is pumped

*Abstract of a paper presented before the International Railway Fuel Association, Chicago, May, 1922.

through to clean out the acid. The strength of the acid varies from 20 to 33⅓ per cent, depending on the nature of the scale.

The highest cost of cleaning the feed water heater is $170.00 per year, both labor and material, and the lowest cost is $2.31. In one case the heater is cleaned by the use of dilute muriatic acid; the other, by a basic solution. An average of the cost data submitted by all the roads for cleaning by the acid process is $62.19 per heater per year, which includes both labor and material.

The cost of other maintenance of the heater proper per year is practically nothing on both the open and closed types. Where weak acid solutions are used, none of the heaters cleaned show any signs of deterioration due to the use of the acid. The territory in which locomotives equipped with feed water heaters operate, includes the greatest range of climatic conditions possible. No serious difficulty has been encountered with any of the feed water heater systems freezing up. Drain valves and telltale pipes have frozen up, but these have given no further trouble after lagging.

Failures of the heater proper while in service have occurred, due to tubes bursting or becoming loose in the tube sheet, heater heads cracking with the closed type of heater, and a crack developed in the cylinder near the discharge valve on the open type of heater. The brass tubes in the closed heater have been replaced by copper tubes, which are more ductile than the brass and a better joint can be made when the tubes fasten into the header. Some trouble has been experienced with the boiler checks pounding out or breaking off with the use of feed water heater equipment. This has been largely overcome by using larger boiler checks with reduced lift.

The boiler feed pump has given good service with all types of heaters. The most common defects which have been encountered are the pump piston rod packing leaking, rods wearing, water valve springs breaking, water cylinder scoring, top head pump gasket leaking, abnormal lift of intake and outlet valves, and valves stuck or leaking. The average cost of maintenance per pump, taken from the data submitted, is $55.16 per year, including labor and material.

The cost of maintenance of the feed water heater apparatus complete averages $97.15 per locomotive for labor and material per year. This figure was determined by averaging the maintenance costs submitted by all the roads, regardless of the type of heater used.

As all the locomotives, which are equipped with feed water heaters, have an injector, no engine failures could be artributed to the operation of the feed water heater apparatus, as the injector was used to supply the boiler in case of the failure of the feed water heater.

Where feed water heaters are applied, the enginemen should be personally instructed relative to the operation of the equipment in order that the highest efficiency may be obtained. The feed water heater pump should only be used to supply the boiler when the engine is working steam, as the exhaust steam from the auxiliaries is not sufficient to heat the water hot enough to show a saving, and the introduction of the cold water into the boiler would tend to cause serious strains in the flues and flue sheets. The rule to pump locomotives with feed water heaters only when working steam, is in force on very nearly all the roads.

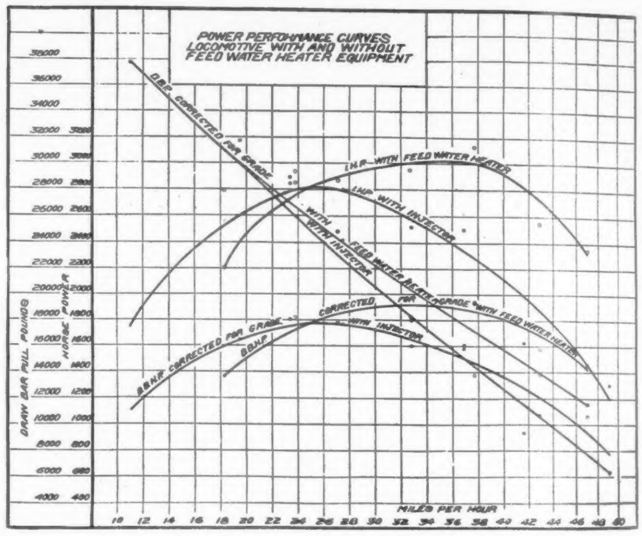
It has been possible to eliminate some water tank stops when the condensate from the feed water heater is returned to the boiler.

On tests made on feed water heater locomotives, the feed water heater shows a saving of between 10 and 16 per cent in fuel, based on the evaporation performance of the locomotive. On two roads where dynamometer car tests had been conducted on feed water heater locomotives, there was a saving of approximately 10 per cent based on fuel consumption per drawbar horsepower. On a thousand ton mile basis, the saving varies from 4 to 11 per cent.

The accompanying power performance chart is based on data taken on dynamometer car tests. It shows that with the feed water heater locomotives, there is an increase of both indicated and drawbar horsepower. This increase in horsepower is due to the back pressure being decreased by diverting about 12 per cent of the exhaust steam from the cylinders to the feed water heater, thus increasing the steaming capacity of the locomotive at high speeds. This increased horsepower will permit an increase in the tonnage rating and average speed of the locomotive.

In its present form the locomotive feed water heater has passed through the experimental stage in this country and the results indicated in this report are typical of what may be anticipated from the application of feed water heaters on other railroads, barring unusual local conditions.

At the present time, the exhaust steam injector as ex-



Results of Dynamometer Tests With and Without Feed Water Heaters

tensively used abroad is being considered as an alternative to the open type of locomotive feed water heater. One American firm is already engaged in the manufacture of this device, and arrangements are being perfected for supplying the railroads in this country with a type of exhaust steam injector that has been successfully used on an extensive scale in England and her colonies.

The report was signed by E. E. Chapman, chairman (A. T. & S. F.); J. R. Alexander (Penn.), E. A. Averill (Superheater Company), J. A. Carney (C. B. & Q.), J. N. Lammedee (Worthington Pump & Mchy. Corp.), L. P. Michael (C. & N. W.), Geo. E. Murray (Grand Trunk), C. B. Peck (*Railway Age*), L. G. Plant (Railway Review), G. B. Von Boden (Sou. Pac.), W. H. Winterrowd (Can. Pac.).

Discussion

H. B. Oatley (Superheater Company), called attention to the fact that feedwater heating has been practiced as long as the injector has been used to feed the locomotive boiler, although in the live steam injector the heat is taken direct from the boiler and is not reclaimed. He then referred to the exhaust steam injector, which has been used extensively in England and the British Colonies, and said that from seven to eight pounds of water could be passed from the tank to the boiler for each pound of steam condensed in the injector; the exhaust steam alone at one, three and five pounds pressure being capable of delivering against boiler pressures of 150 lb., 165 lb. and 180 lb. respectively. A small amount of line steam is required to supplement the exhaust steam for delivery against higher pressures. Mr. Oatley suggested that the possibilities of heat reclamation with the exhaust steam injector compare favorably with those of other types of feed water heaters.

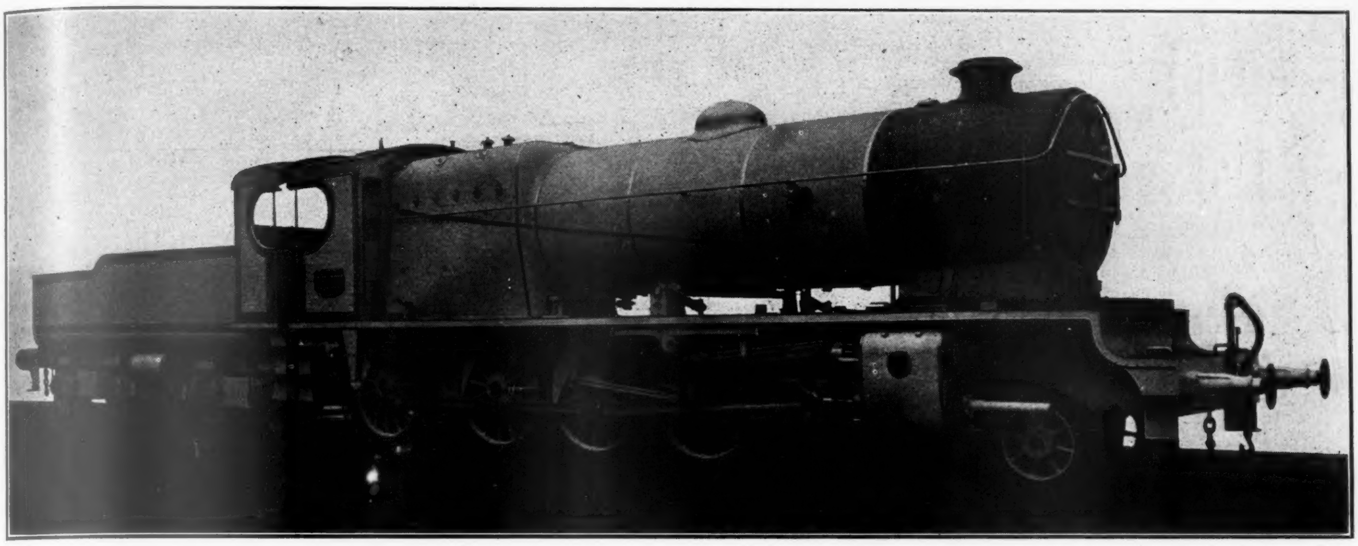


Fig. 1—Three-Cylinder Locomotive Built by Yorkshire Engine Company, Ltd.

Three-Cylinder Locomotive for Spanish Service

Heavy 4-8-0 Type of an Unusually Well-Worked-Out Design with Many Interesting Features

LOCOMOTIVES of the three-cylinder single-expansion type are meeting with increasing favor on British and also on a number of European roads which are noticeable for advanced designs. Engines of this type are being designed for heavy power to be used in either passenger or freight service and are taking the place of compound and four-cylinder simple locomotives.

Spain is a country intersected by a number of mountain ranges which form barriers between many of the principal cities and the seaports. As a result of the relatively sparse population and the high cost of railroad construction due to the mountainous character of the country a large amount of the mileage is of single track and frequently with long and heavy grades. Moreover, the lightness of the bridges and rails does not admit of a high axle load. The two largest railroads are the Madrid, Zaragoza y Alicante and the Norte, each of which has about 2,300 miles of 5 ft. 6 in. gage line. On the former the axle load is limited to 16 metric tons (35,260 lb.) and on the latter to 15.8 metric tons (34,825 lb.). In addition, the maximum allowable running weight over locomotive and tender buffers is 6 metric tons per meter, or 4,035 lb. per foot. The minimum radius of curves around stations is 200 meters (656 ft.).

For many years much more powerful locomotives have been used in Spain than are ordinarily employed on European railroads. A number of these locomotives have been built in the United States as, for example, the lot of 25 four-cylinder balanced compounds of the 4-8-0 type delivered to the Madrid, Zaragoza y Alicante in 1917 by the American Locomotive Company. These were practically duplicates of previous German locomotives, weighed 192,900 lb. for the engine in working order exclusive of the tender and exerted a tractive effort of 35,500 lb. simple and 29,550 lb. compound. In 1920 another lot of 15 locomotives was delivered to the same road. They, however, were of the Pacific type, designed along American lines, had 23 in. by 26 in. cylinders, 65 in. wheels, weighed 188,500 lb. and were proportioned for a tractive force of 28,830 lb.

The Spanish Government recently adopted a high tariff on imported goods with the object of fostering the manufacture in Spain of machinery and other commodities including locomotives. As a result of the inauguration of this protection policy, La Sociedad Espanola de Construcciones Babcock y Wilcox, which has a large new plant at Bilboa, decided to add the building of locomotives to their line of manufacture. An order for a sample locomotive to meet Spanish requirements was consequently placed by them with the Yorkshire Engine Company, Ltd., Meadow Hall Works, Sheffield, England. The locomotive, which is of the three-cylinder, 4-8-0 type, has now been delivered and will be tested out on several Spanish roads.

The weight of the locomotive in working order is 194,400 lb. of which 137,000 lb. are on the drivers and 57,400 lb. on the front truck. The tender, which is carried on two four-wheel trucks, has a capacity of 4,840 gal. of water and seven tons of coal and weighs 112,500 lb. in working order. These figures correspond to a driving axle load of 34,250 lb. and as the length of locomotive and tender over buffers is 76 ft. 2½ in., the weight per running foot is 4,027 lb. or practically the allowable maximum.

As the weight on the drivers is 137,000 lb. and the rated tractive force, calculated on a basis of 85 per cent m.e.p. is 41,950 lb., this gives a ratio of 3.27 to 1, a low figure but apparently entirely practical on account of the even torque produced by the three cylinders with cranks set at 120 deg. In fact the three-cylinder system appears to be the logical solution of the problem of designing a locomotive of high tractive force with restricted axle loadings.

From the table of dimensions, weights and proportions it will be noted that the weight is 92.6 lb. per cylinder horsepower and 114.2 lb. per boiler horsepower which shows good designing in the use of materials.

The boiler horsepower, calculated according to the practice of the American Locomotive Company, is only 1,702 whereas the cylinder horsepower is 2,100. The coal rate per square foot of grate per hour is 136 lb., assuming coal to be of 12,000 B.t.u. value. The boiler capacity is less than would appear to be advisable judging by American experience.

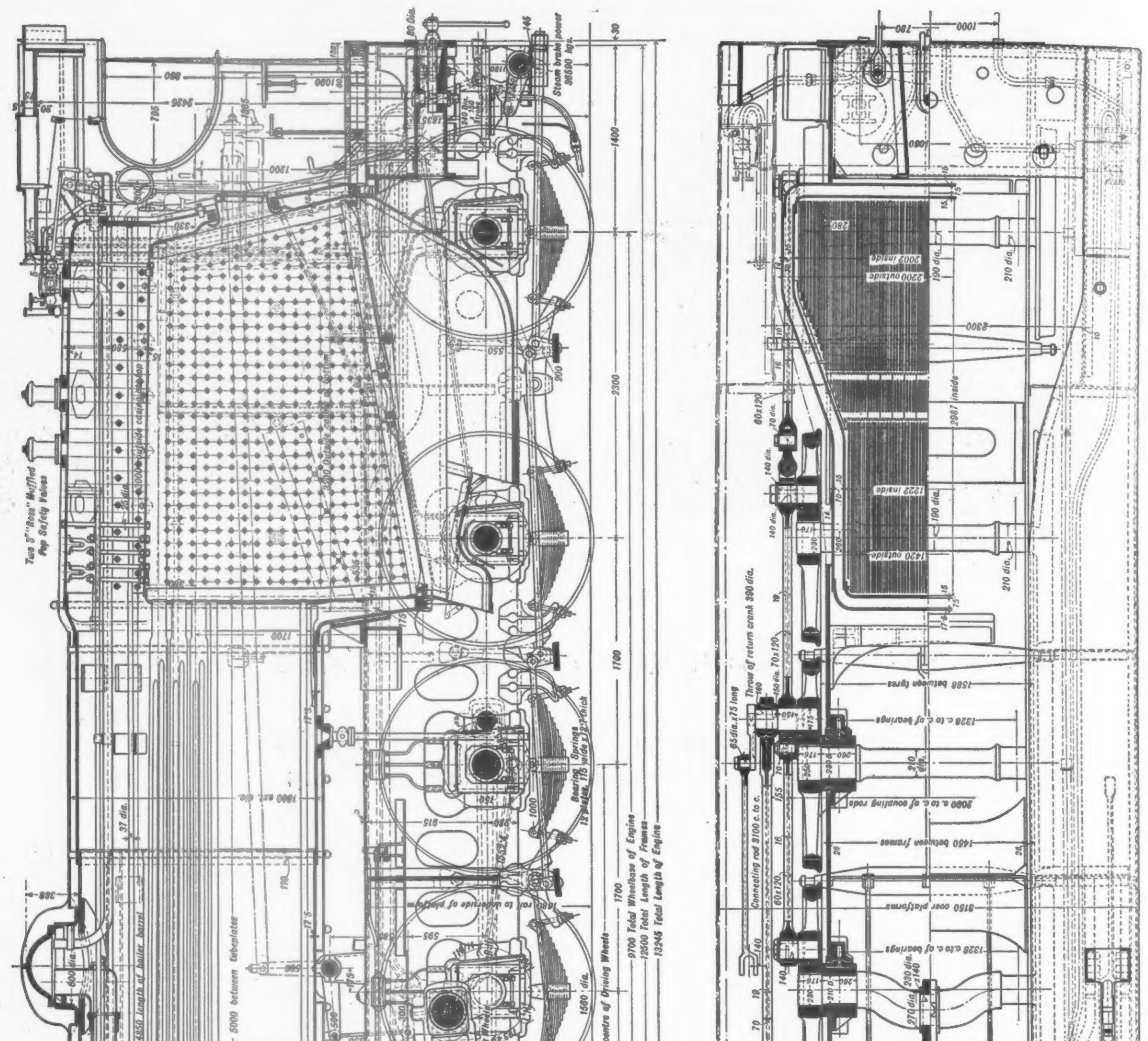


FIG. 2—ELEVATION AND PLAN OF THREE-CYLINDER LOCOMOTIVE FOR SPAIN

All Dimensions are given in Millimeters

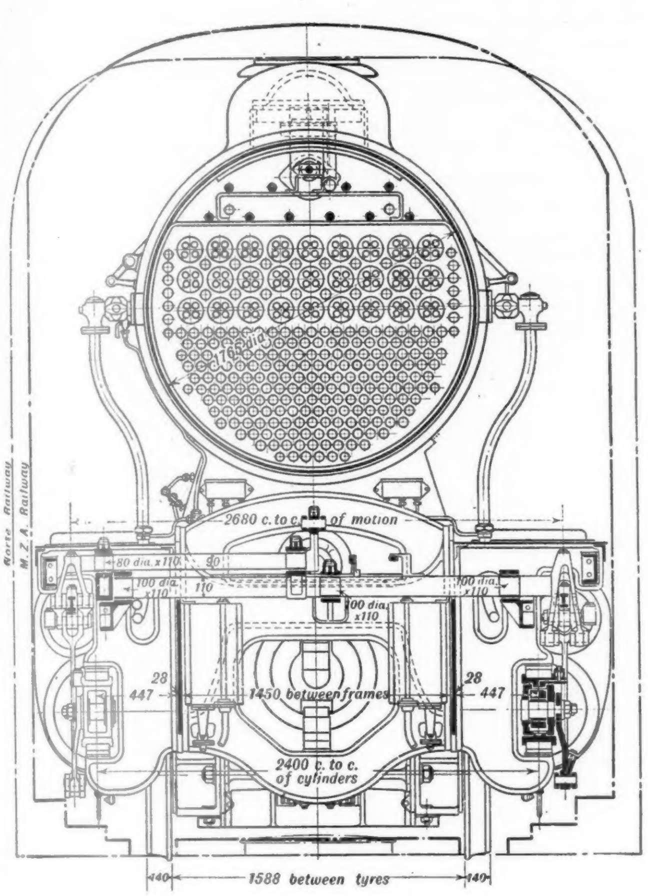


FIG. 3—SECTION THROUGH BOILER

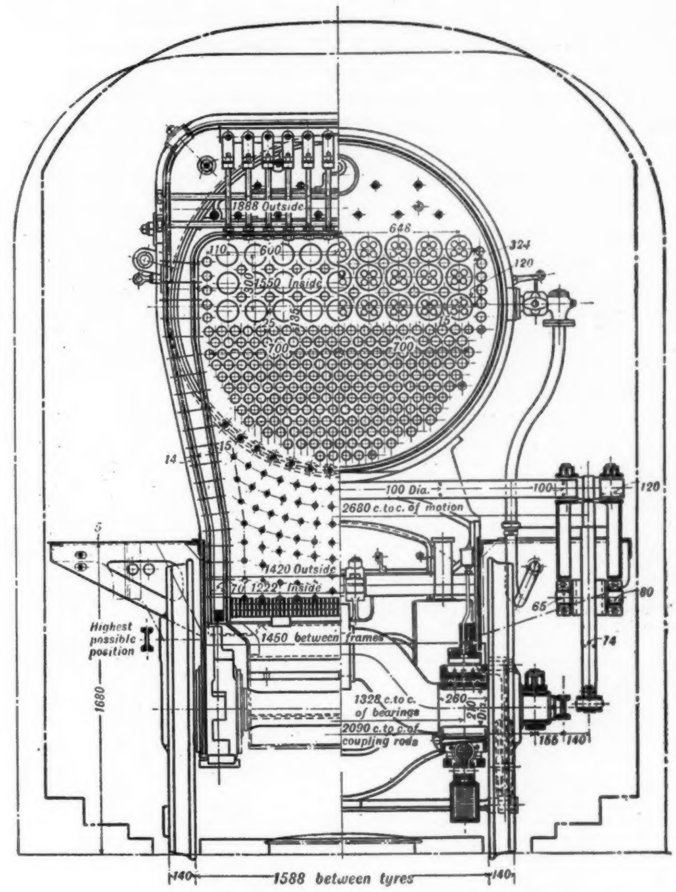


FIG. 4—SECTION THROUGH FIREBOX AND CRANK AXLE

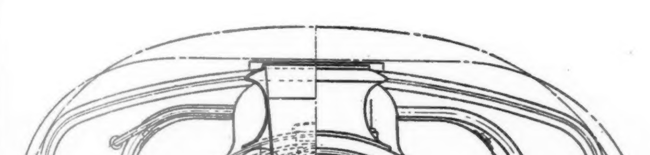


FIG. 5—SECTION AT CYLINDERS AND HALF-FRONT VIEW

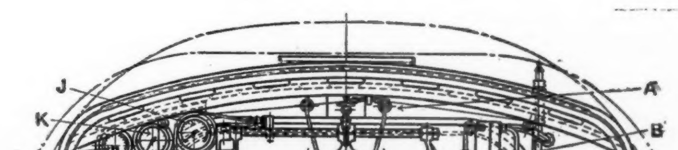


FIG. 6—REAR VIEW AND ARRANGEMENT OF CAB

Moreover the grate area, one square foot for 42 hp., is less than would be used in this country, especially in view of the rather low grade of Spanish coals.

The general design is well shown in the elevation and cross section drawings which are reproduced from the description of the locomotive given in the Engineer, London.

All three cylinders are of the same size; namely, 20½ in. by 26 in. The outside cylinders are horizontal and

TABLE OF DIMENSIONS, WEIGHTS AND PROPORTIONS

	Metric	English
Cylinders, 3 of	520 mm. by 660 mm.	20½ in. by 26 in.
Valve gear	Walschaert type	....
Valves, piston type, size	260 mm.	10¼ in.
Outside lap	27 mm.	1⅝ in.
Exhaust clearance	3 mm.	3/16 in.
Weights in working order:		
On drivers	62,000 kg.	137,000 lb.
On front truck	26,000 kg.	57,400 lb.
Total engine	88,000 kg.	194,400 lb.
Tender	51,000 kg.	112,500 lb.
Wheel base and length:		
Driving	5.700 m.	18 ft. 8⅜ in.
Total engine	9.700 m.	31 ft. 9⅞ in.
Total engine and tender	18.930 m.	62 ft. 1¼ in.
Total length over buffers	23.230 m.	76 ft. 2½ in.
Wheels, diameter outside tires:		
Driving	1.560 m.	61 7/16 in.
Front truck	0.860 m.	33⅞ in.
Tender	1.080 m.	42½ in.
Journals, diameter and length:		
Driving, second	230 mm. by 260 mm.	9 in. by 10¼ in.
Driving, others	210 mm. by 260 mm.	8¼ in. by 10¼ in.
Front truck	160 mm. by 290 mm.	6¼ in. by 11 7/16 in.
Boiler:		
Type	Raised Belpaire	....
Steam pressure	13 kg. sq. c.m.	185 lb.
Diameter, first ring, outside	1.800 m.	70⅞ in.
Firebox, length and width	2.989 m. by 1.222 m. and 2.002 m.	100 in. by 48 in. and 79 in.
Height, grate to crown sheet, back	1,420 mm.	56¼ in.
Height, grate to crown sheet, front	1,980 mm.	77¾ in.
Tubes, number and outside diameter	218—0.050 m.	218—1.97 in.
Flues, number and outside diameter	27—0.133 m.	27—5.23 in.
Length between tube sheets	5.000 m.	16 ft. 4⅞ in.
Tube spacing	20 mm.	25/32 in.
Flue spacing	17 mm.	11/16 in.
Grate type	Orleans	....
Grate area	4.65 sq. m.	50 sq. ft.
Heating surfaces:		
Firebox	18.4 sq. m.	198 sq. ft.
Tubes	171.0 sq. m.	1,840 sq. ft.
Flues	56.8 sq. m.	610 sq. ft.
Total evaporative	246.2 sq. m.	2,648 sq. ft.
Superheating	47.1 sq. m.	507 sq. ft.
Comb. evaporative and superheating	493.3 sq. m.	3,155 sq. ft.
Tender:		
Water capacity	22,000 kg.	4,840 gal.
Fuel capacity	7,000 kg.	7 tons
General data, estimated:		
Rated tractive effort, 85 per cent	18,970 kg.	41,950 lb.
Cylinder horsepower	....	2,100 hp.
Boiler horsepower	....	1,702 hp.
Speed at maximum horsepower	68 km. p. h.	42.2 m.p.h.
Steam required per hour	....	43,680 lb.
Boiler evaporative capacity per hour	....	35,400 lb.
Coal required per hour, total	....	6,825 lb.
Coal, rate per sq. ft. grate per hour	....	136 lb.
Weight proportions:		
Weight on drivers ÷ tractive force	....	3.27
Weight on drivers ÷ total weight engine	....	70.5
Total weight, engine ÷ cylinder horsepower	....	92.6 lb
Total weight, engine ÷ boiler horsepower	....	114.2 lb.
Boiler proportions:		
Boiler horsepower ÷ cylinder horsepower, per cent	....	81
Comb. heating surface ÷ cylinder horsepower	....	1.50
Tractive force ÷ comb. heating surface	....	13.30
Tractive force × dia. drivers ÷ comb. heating surface	....	817
Cylinder horsepower ÷ grate area	....	42
Boiler horsepower ÷ grate area	....	34
Firebox heating surface ÷ grate area	....	3.96
Firebox heating surface ÷ evap. heating surface, per cent	....	7.5
Superheating surface ÷ evap. heating surface, per cent	....	29.2
Tube length ÷ inside diameter	....	111

coupled to the second pair of wheels by main rods 122 in. long. The inside cylinder is set forward of the other cylinders and inclined at 1 in 15, the main rod, which is connected to the forward axle, being 82¾ in. long. This arrangement secures a main rod of reasonable length for the inside cylinder and gives a good distribution of driving stresses on the various axles. Each cylinder is cast separately, the inside cylinder being integral with the smokebox saddle. There are only two steam pipes in the smokebox. Each passage is divided into two, one going to the inside steam chest and the other to the outside steam chest. Exhaust passages are short and direct. A by-pass valve is applied to each cylinder. These valves are entirely automatic in their action, remaining closed as long as there is pressure in the steam chest and opening when steam is shut off or when excessive compression occurs.

Particular attention was taken to secure lightness as well as strength and durability in all moving parts. Pistons are of forged steel, finished all over. Valves are of the hollow piston type with inside admission and have forged steel heads, machined all over and welded to a section of solid drawn tubing. In addition to using channel sections for main and side rods, some of the motion parts are also of channel section.

The crank axle is of circular section, forged in one piece and bent to shape. Driving boxes are of cast steel with phosphor-bronze bearings.

Plate steel frames, 1⅛ in. thick, reflect British practice as does the use of underhung springs, which are equalized in two groups. The front truck has a side play of 2⅜ in. each way and is centered by elliptic springs.

All three valves are driven by two gears of the Walschaert type. The outer valves are connected to the gear in the usual manner. The motion of the inside valve is obtained by means of a rock shaft carried in fixed bearings and driven from one side of the engine. This shaft, which has arms in the ratio of 2 to 1, carries a floating shaft in bearings formed in its short arms. The arms of the floating shaft are of equal length and it is driven from the other side of the engine. The general arrangement has been successfully used on a number of three-cylinder locomotives. This design gives straight line connections and permits the withdrawal of any of the piston valves without interference with the valve gear.

The boiler is of the raised-top Belpaire type with "Orleans" type firebox. The grate surface is 100 in. long, 79 in. wide at the back end, where the grates are raised above the rear drivers, and only 48 in. wide at the front, where the grates slope down between the third pair of drivers. This arrangement gives a good firebox volume with sufficient space between grates and the brick arch without unnecessarily raising the center line of the boiler.

The superheater and regulator or throttle valve are of special design, patented by Babcock and Wilcox. A 7-in. saturated steam pipe is carried from the dome to the cast steel

INDEX TO CAB FIXTURES

A—Injector steam cocks
B—Dewrance's water gages
C—Six-feed vacuum lubricator, capacity 6 pts.
D—Hasler speed indicator and recorder.
E—Heintz steam heating valve
F—Blower cock
G—Drop grate handle
HH—Gresham and Craven's No. 10 hot water injectors
J—Steam pressure gage
K—Steinle pyrometer
L—Duplex vacuum gage
M—30/20 Dreadnaught ejector with steam brake valve
N—Leading sanding handle
P—Cylinder cock handle
Q—Steam sanding valve

throttle chamber casting in the smokebox and thence to a forged steel leader from which branches lead to the 27 superheater elements which are of 1½ in. outside diameter. The superheated steam passes to another header connected to the front portion of the throttle chamber casting. The throttle valve is of the hollow piston type and when closed permits the superheated steam to flow through it and pass to the boiler through a small return pipe. This return pipe is open when the steam is shut off from the cylinders and closed when the main throttle valve is opened. By this arrangement dampers and circulating devices are not required. Superheated steam is always instantly available while the expansion of steam in the superheater elements cannot cause the engine to be started unintentionally.

The cab is arranged for left hand operation and the various fixtures are conveniently placed as will be observed from one of the drawings. The accompanying table gives the names of the different devices.

The driver brake rigging is of the equalized type with brake shoes on the front side of all driving wheels and is well designed, although American practice would favor the use of separable brake shoes and heads with shoes applied on the back side of the wheels. The driver brakes are operated by two steam brake cylinders, 9½ in. diameter by 6 in. stroke. The braking power is 36,590 kg. (80,600 lb.) or 59 per cent of the weight on the driving wheels. The locomotive is equipped with Gresham and Craven's "Dreadnaught" ejector for the operation of the vacuum brakes on the tender and train.

The design of this locomotive is of more than ordinary interest and it is hoped that we will be able to secure information in regard to its performance at some future date.

Strength of Welded Pressure Containers*

THE following conclusions were reached as the result of an investigation of pressure tests on electric welded, gas welded and riveted pressure containers, similar to air reservoirs used in railroad service, furnished by the Vilter Manufacturing Company, Milwaukee, Wis. Tension and shear tests on specially prepared specimens of welded metals, also were made, demonstrating the strength and uniformity of construction secured by electric welding. In all nine containers were tested, using pressures from 200 to 2,100 lb. per sq. in. The containers were 15¼ in. in internal diameter and 10 ft. long with inserted dished ends held in place by electric welding.

Some of the more important points brought out by the tests are enumerated and discussed below.

Weak points in the containers. None of the welded containers of standard design failed primarily at the welded head joint. The nature of the fracture shows that the weak points in the containers were, first, the lap weld in the pipe forming the shell, where failure occurred due to circumferential tension, and, second, the body of the shell at its junction with the head flange, where failure occurred due to the combination of longitudinal tension and bending. It appears that leakage is likely to occur first where couplings and nipples are welded in. This is due to the fact that the metal of the shell stretches and pulls away from the nipple, which does not have a corresponding strain induced in it by internal pressure.

Strength of electric welds. From the tests on four specially prepared specimens, the average tensile strength of electrically welded joints was found to be 28,500 lb. per sq. in. From tests on five specimens cut from containers, the average shearing strength of electrically welded joints was found to be 25,500 lb. per sq. in. The mean variation from the average tensile strength per linear inch of weld was found to be 2 per cent, and the maximum variation 4.5 per cent. The mean variation from the average shearing strength per linear inch of joint was found to be 5.2 per cent and the maximum variation 7.8 per cent. The results of eccentric tension tests on specimens cut from containers showed that no one of the specimens was markedly weaker than the average for the lot. It is believed that the uniformity of strength thus indicated is of especial interest and importance.

In connection with the values given above for tensile strength, two points should be noted. First, at the section through the weld, where failure took place, the load was eccentric, because of the fact that the specimen is unsymmetrically thickened at that point by the joint. This eccentricity undoubtedly made the average stress on the joint at failure less than it would otherwise have been, and so the values obtained were less than the actual tensile strength of the metal. The effective eccentricity was not as great as one-half of the excess thickness of the joint, because the ends of the specimen were restrained. No attempt has been made to allow for the effect of this eccentric loading, because it represents a condition inherent in any so-called single-V weld which has an excess thickness.

Second, each of the four specimens had, within its tested length, several transverse welded joints. The strength of each specimen, therefore, represents the strength of the weakest of these seven joints, and so the value given, 28,500 lb. per sq. in., is less than the average strength for all joints.

Relative strength of electrically welded and riveted joints. The tension tests indicated that the resistance to tension applied with a large eccentricity is greater for the riveted joint than for the welded joint. The shear test indicated that the resistance to shear per linear inch of joint is greater for the welded joint. Measurements to determine the elastic and permanent protrusion of the container heads showed that for the two specimens so tested the welded container withstood a somewhat greater pressure without permanent distortion. In the case of the riveted containers, leakage occurred at the head joints under moderate pressures. In the case of the electrically welded containers there was no leakage at the head joint under any pressure.

Efficiency of electrically welded joints. While it is customary to speak of the efficiency of a joint, whether welded or riveted, meaning the ratio of the strength of joint to strength of plates joined, the writer does not believe that this ratio is especially significant in the case of electrically welded joints nor that any generally applicable value can be given.

It is apparent that while the strength of the plates joined is dependent solely on the physical properties of the base metal, the strength of the weld is in great measure dependent on the properties of the filling metal. Furthermore, the per cent excess thickness of the weld, which influences its strength, varies with the thickness of the plates. Accordingly the efficiency of a weld depends on the properties of the base metal, the filling metal, and the thickness of the plates.

The writer believes that the correct method of computing the efficiency of an electrically welded joint is on the basis of a specified minimum strength of base metal, a specified minimum excess thickness of weld and an experimentally determined average (per sq. in.) of the metal, of which the finished weld is composed.

*From a paper presented by Assistant Professor R. J. Roark, University of Wisconsin, at the spring meeting, Atlanta, Ga., May 8-11, 1922, of the American Society of Mechanical Engineers.

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The Erie Triplex on the Susquehanna Grade

WHAT OUR READERS THINK

Suggestion for Locomotive Designs

PHILADELPHIA, Pa.

TO THE EDITOR:

One of your correspondents in the May issue suggests the use of a high speed reciprocating engine, coupled to the wheels through a reduction gear, for a steam locomotive. While not impossible, a drive of this kind would be difficult to apply and the expense would, without doubt, be in excess of the present almost universal two outside cylinders.

As I see it, one of the principal things standing in the way of the turbine drive for the steam locomotive is this same matter of a reduction gear. Having worked on reduction gears, I was surprised when I first started at the amount of room that they took up in comparison with that needed for the two cylinders of the locomotive. A small condensing unit, say for 600 kw., will be about 10 ft. long, or just about the limit of the available space under a locomotive and a unit large enough for a good sized engine would be too large to get in. This represents stationary and marine practice, but it is possible that for railroad work something smaller might be built.

The problem of designing an engine to go inside the smokebox and arranging for the smoke and cinders to pass by it without damaging the engine or cutting off the draft is a difficult one. The crossheads and guides would have to be entirely enclosed and the rods would have to be protected. It would be necessary for the rods to extend through the smokebox to the pinion shaft below, because the pinion shaft could hardly be expected to run in the heat of the smokebox. This means that there would have to be an air tight covering for the rods, otherwise the draft would be broken.

While at first sight the proposition looks favorable on account of the smoother running of the small engine and the probable more favorable action on the rail, it would seem that the same results could be obtained more cheaply by the use of a third cylinder between the frames. The use of three cylinders has been tried on but one road in this country so far as I know, and it was abandoned with a change of management on account of the increased difficulty of keeping the engines in service.

GEORGE L. CLOUSER.

Co-operation, Not Criticism, Needed

LORAIN, Ohio.

TO THE EDITOR:

Comments by "Mechanic" and "Supervisor" in the April and May issues of the *Railway Mechanical Engineer* if continued along the same line, will not be productive of much good to any of us. Endless carping criticism will not get us anywhere, rather let us have a constructive criticism. The position of any railroad supervisor is not one to be envied, their responsibility does not cease with the blowing of the quitting time whistle; the majority carry their load every minute of the 24 hours. At the finish of one day any plans for the next may be entirely upset by the unexpected happenings which occur in the motive power department; to meet these exigencies taxes the ingenuity and patience of any foreman and if, as "Mechanic" states, engines are sent out with work not completed or not done, he can rest assured that the spirit of the I. C. C. laws is complied with, if not exactly to the letter.

The I. C. C. laws do not demand a 100 per cent engine, but do ask that an engine be in a reasonably safe condition. Can "Mechanic" say with his years of experience that he has looked over some engines just new from the builders and found them perfect; can he not recall some little defect which, as he and others talked it over, grew from a mole-hill to a mountain?

The writer is one in the ranks and has been for 29 years. The longer I am in the game, the more I see the need of a get-together spirit. Foremen are not perfect, neither are the mechanics. There is just as much egotism in shop men as there is among the supervising forces. "Mechanic" may have been unfortunate to have as a foreman one who is not big enough in character, nor broad enough in principle to occupy such a position. There are such, we know, but it takes all kinds of people to make a world and if we have such an opinion of a foreman, ten chances to one he has a worse opinion of us. One of the brightest spots in my railroad life came a few days ago when our local supervising head called all the men in the shop together and asked for a better understanding and more of a fifty-fifty feeling between us, the men and the company. Co-operation is what is needed; it is not an impossibility, it is one of the steps to a better understanding of each other's difficulties.

JOSEPH SMITH.
Boiler Inspector, Baltimore & Ohio.

Why College Men Do Not Stay in Railroad Service

WHEATON, Ill.

TO THE EDITOR:

It is with considerable interest that I have read many letters, editorials and communications in the *Railway Mechanical Engineer* and the Railway Age pertaining to the employment of college men in the motive power departments of our railroads. I wonder if my own case is typical of the few college men who have entered railroading as a life's vocation. If so, I believe the reason for so few men entering the doors of this, the country's greatest industry, is quite evident.

The writer graduated from one of the leading western universities six years ago and it is not without a little pride that he can point to the fact that he was awarded final honors in this institution. This statement is made simply to combat one made in the Daily Edition of the Railway Age, which statement declared that the better class of college men do not enter the employment of the railroads but that only the dregs or those who cannot find employment elsewhere are really available.

Upon graduation the writer entered the service of Uncle Sam as an officer in the Coast Artillery. Again it is not without some honest pride that the writer can state that he received honors while in the service. Also, he received some valuable training in the handling of skilled mechanics and expensive machinery.

Upon discharge from the army, the writer entered the service of a large western road as a special apprentice. In spite of very low rates of pay, lay-offs, strikes and the like, the course was finally completed to the complete satisfaction of the subordinate officials with whom he came in daily contact.

During the above apprenticeship course the writer spent

over a year giving the company the benefit of his technical knowledge in the testing of locomotives and their accessories. In the performance of this work he repeatedly had men and foremen under his direction whose compensation was twice or thrice that of the writer. Also, reports were prepared out of hours in order that busy officers might have them at the time demanded, this without any extra compensation or commendation. The above was willingly done, however, due to a long entertained and real liking for railroad work.

Upon completion of the course the writer was offered two alternatives, one to accept a position as a machinist with the company, and the other to sever relations and find employment elsewhere. He was told that there were no vacancies among the positions of subordinate officers or foremen at the time but that he would be kept in mind when one did arise. Because of a liking for the work the position as a machinist was accepted. Since that time many vacancies for the better positions have occurred but the writer is still a machinist.

On July 1 the writer of necessity went on strike with the rest of the shopmen. Practically I am "outlawed" from my chosen vocation. Therefore, as many college men before me have done, it becomes necessary to leave railroading as a vocation and find some other line of work, in spite of the fact that I prefer my present work and have had considerable training in it—all this at an age when I should be fairly well settled in some vocation for life.

If my experience has been typical of that of most college men, perhaps one of the main reasons for the scarcity of technical men in the motive power departments of the various railroads is evident. A College Man.

AIR BRAKE CORNER

1923 Air Brake Association Convention

Steps are already being taken to make the convention at Denver in May, 1923, one of the most important gatherings in many years. Any member who has suggestions to offer as to subjects or otherwise, should communicate immediately with F. M. Nellis, secretary.

This year's convention at Atlantic City was well attended, as is evidenced by the registration of 310 members and 154 guests, or a total of 464. The presiding officer was L. P. Streeter, president. The officers elected for the ensuing year were: President, Mark Purcell (Northern Pacific); first vice-president, George H. Wood (Atchison, Topeka & Santa Fe); second vice-president, Charles M. Kidd (Norfolk & Western); third vice-president, R. C. Burns (Pennsylvania); secretary, F. M. Nellis (Westinghouse Air Brake Company); treasurer, Otto Best (Nathan Manufacturing Company). The election of Mr. Burns to the office of third vice-president left a vacancy on the executive committee, which was filled by the selection of Harry Flynn (Delaware & Hudson).

Defective Locomotive Brake and Train Operation

Five questions to which answers were invited were given on page 331 of the June issue. Many excellent replies have been received, some of which give correct answers to part of the questions but overlook certain points in connection with the answers to other questions. Taking all points into consideration, the best reply was from F. A. Pearce, Battle Creek, Mich. Others who sent in well-considered answers were S. P. Kennedy, Pittsburgh, Pa.; V. O. Yingst, Bethlehem, Pa.; D. A. Wade, San Antonio, Tex.; G. B. Killinger, Corbin, Ky.; R. F. Walker, Montreal, P. Q.; H. V. Reagan, Pittsburgh, Pa., and C. A. Wolfe, Bloomington, Ill. The following are the answers given by Mr. Pearce, supplemented by additional suggestions from others.

Question 1—How could a train be handled if the brake pipe was broken behind the connection leading to the automatic brake valve in either A1 or ET equipment?

Answer—Plug the end of the broken pipe, then force together the signal and brake pipe hose couplings at the head end of the engine, cut the brake pipe into the signal line by opening the cocks at the front end, force together the signal and brake pipe couplings at the rear of the tender and cut out or blank off the connection from the reducing valve or check valve to the signal line. This will leave the signal system and also the brakes on the tender inoperative but the brake on the locomotive and on the train can be handled in the usual manner.

If the equipment is schedule A1, the coupling of brake pipe and signal hose should be made between the engine and tender instead of at the rear of the tender as by so doing the automatic tender brakes will remain operative. With the ET equipment the tender brakes will still be operative regardless of whether the brake pipe and signal lines are connected in front of or at rear of the tender, the only advantage with the ET equipment of making the coupling between the engine and tender is that the brake pipe vent valve will still operate provided the tender is thus equipped.

In answering this question several assumed that the locomotive if not fitted with the ET equipment would have the A1 equipment and also the combined straight air brake. One of the best answers based on this assumption was from V. O. Yingst, who said, "Plug the pressure end or apply a blind gasket in the connection at the automatic brake valve. Then cut out the driver and engine truck brake cylinders, couple the brake cylinder hose on the back of the engine to the brake pipe hose on the tender and with the independent brake valve in slow application position adjust the reducing valve and safety valve (as used on ET or straight air brake equipment) to the desired brake pipe pressure. To charge the brake pipe place handle of the independent or straight air brake valve in application position—the brake pipe will be charged through the distributing valve or through the straight air brake valve used with the A1 equipment. To apply the brakes slowly place handle in release position until the desired brake pipe reduction has been made, brake pipe air being exhausted through the distributing valve brake cylinder exhaust or straight air release pipe as used on the A1 equipment. If on a long train and ET equipment, it is advisable to remove the choke fitting at the cut-out cock back of the engine."

Question 2—If the automatic brake would not apply but the independent brake functioned properly, where would the trouble be?

Answer—The preliminary exhaust port in the automatic brake valve seat may be obstructed, the exhaust fitting of the brake valve obstructed, the equalizing piston in the automatic brake valve stuck, or the distributing valve equalizing piston stuck or too tight, thus not moving when the brake valve is placed in service application position.

Several other possibilities were suggested. Among them were the following distributing valve defects: Body gasket blown out; feed groove plugged up; defective, loose or missing safety valve; broken stem or lug on equalizing piston; leakage from pressure chamber.

The answer from Mr. Yingst is also worth attention. "The brake pipe being fully charged and the double heading cock open, the trouble may be due to the cut-out cock in the brake pipe branch pipe to the distributing valve closed or the equalizing portion frozen. A defective gasket above the brake valve equalizing piston or a bad rotary valve causing air to leak into chamber D, destroying the preliminary exhaust feature. A worn ring in the equalizing piston of the

brake valve (this is rare) allowing brake pipe air to leak by the ring into chamber D also destroying the preliminary exhaust, the brake pipe exhaust fitting being plugged by dirt, etc. I have known a case where the signal line instead of the brake pipe had been piped to the distributing valve. On another occasion a brake valve rotary valve key came out of place due to the rotary being faced beyond the limit with the result that the handle could be moved but the rotary valve remained stationary."

Question 3—If the automatic brake would not apply on a long train but operated correctly when the engine was detached from the train, where would you look for the trouble?

Answer—Make sure that the brake pipe hose between the tender and the first car was not obstructed by a loose lining or otherwise and see that all cut-out cocks are open.

Other possible defects are: Equalizing piston ring of distributing valve loose or broken; enlarged feed groove in distributing valve; restricted exhaust from automatic brake valve.

Question 4—If, when applying the brake with either brake valve—the engine being equipped with the ET brake—the main reservoir pressure began to fall, where would you look for the trouble and what should be done to avoid stalling?

Answer—On the supposition that the train is going at a fair speed and that the engineman wishing to slow down makes a service application with the automatic brake valve, and watching his gage, notices the main reservoir begin to fall, this would denote a bad leak in the brake cylinder or brake cylinder pipe because in applying with the H-6 automatic brake valve, the pressure chamber pressure flows to the application cylinder of the distributing valve, forcing the application piston and valve to the right and so allowing the main reservoir pressure to flow to the brake cylinders. With the above mentioned leak, the main reservoir pressure would fall rapidly. To avoid stalling, use the automatic brake valve, setting the brakes with a service application—at the same time holding the independent brake valve handle in full release position. This will set the train brakes, but with the independent brake in full release the air is continually released from the distributing valve application chamber, leaving no pressure to force the piston and valve over and allow the main reservoir pressure to pass to the driver brake cylinders. This would destroy the engine and tender brake but at the first stop the defective brake cylinder or pipe could be cut out.

Question 5—On an engine equipped with the ET brake, if the feed valve pipe was broken between the feed valve and the brake valve, what should be done?

Answer—Screw back the regulating nut on the feed valve so that no air comes through feed valve. Carry the automatic brake valve handle in full release thereby charging the brake pipe through the brake valve with main reservoir pressure. When applying the brakes work the brake valve handle to service application until the desired reduction has been made, then to lap. To release the brakes, place the brake valve handle in full release position, which releases the train brakes, then to running position to release the engine and tender brakes, again going back to full release position to recharge the brake pipe.

Methods of plugging which would permit the automatic brake valve to be used in the ordinary manner were suggested, also readjustment of the pump governor, but these would take time and would hardly be necessary. However, the following procedure outlined by R. F. Walker is interesting and effective: "Remove the feed valve cap nut, take out the piston spring and spring tip and apply a wooden plug between the cap and the supply valve piston to hold the supply valve in closed position when the cap is screwed home. Take off the regulating valve cap, remove the valve and spring and apply a rubber plug between the cap and the regulating valve seat to prevent the leakage of air past the supply valve piston from escaping through the broken pipe. Remove the cap from the excess pressure head of the pump governor and screw the adjusting nut down tight, allowing the maximum pressure head to govern the pump. In handling the brake use the release position and keep a close watch on gages, returning the automatic valve handle to lap position as soon as the brake pipe pressure is up to the maximum. Unless the feed pipe next to the brake valve can be plugged, it will be necessary to avoid running and holding positions, using full release position of the independent brake valve to release the engine and tender brakes. If the break in the pipe is near a union or any fitting where a gasket can be placed to plug it, the running position can be used and the brake pipe reduction caused by the leakage of equalizing reservoir pressure avoided. Otherwise a close watch will have to be kept and release used on such occasions. Watch the brake pipe gage closely and maintain proper pressure by using the release position of the automatic valve. No harm other than the possibility of bursting hose will result if the brake pipe is slightly overcharged. The main reservoir cut-out cock and double-heading cock should be closed to prevent loss of reservoir and brake pipe air while the feed valve is being plugged."

Another method was suggested by S. P. Kennedy. "Run out the adjusting screw of the feed valve to prevent loss of reservoir pressure. Lap the brake valve, then plug the broken feed valve pipe from the brake valve. Charge the 'SF' governor automatic brake valve pipe from the bottom connection of the excess governor head to the connection on the maximum pressure governor head. Plug or blank the main reservoir governor pipe and adjust the maximum pressure governor head to the pressure desired in the brake pipe, thus the governor will act as a feed valve. When the brake valve is moved from the full-release position—in which position it must be carried while running in this case—to lap, service or emergency, the governor will automatically allow the compressor to pump up an excess main reservoir pressure to release the brakes and recharge. The pump throttle may be controlled to prevent high excess pressure to accumulate and possibly overcharge the brake pipe when releasing and recharging. If the 'SG' governor is used the excess pressure head regulating pin valve must be continuously held to its seat, its port plugged or a piece of rod or wood inserted in its regulating spring case to hold the valve closed by tension of adjusting screw. The brake valve should be handled in full release position as otherwise."

THE QUESTION BOX

A or B End of Car

Question.—A.R.A. Interchange Rule 14 designates that "The end of car towards which the cylinder push rod travels shall be known as *B* end and the opposite end shall be known as *A* end." I would like to know how to designate the ends of a car on which the cylinder push rod travels downward in a vertical direction or on another car on which the cylinder is located directly in the center of the car and with the push rod traveling crosswise. Again, there are several thousands of steel hopper cars in service on which the cylinder is located directly over the center sills with the pressure head of the brake cylinder flush with the end post, the piston rod moving toward the center of the car when the air brake is applied. The hand brake is located on the same end as the cylinder on these cars.—F. J. B.

The *Railway Mechanical Engineer* publishes this question in the hope that some of those who have had to do with such cars will tell how they designate the ends.—*Editor.*

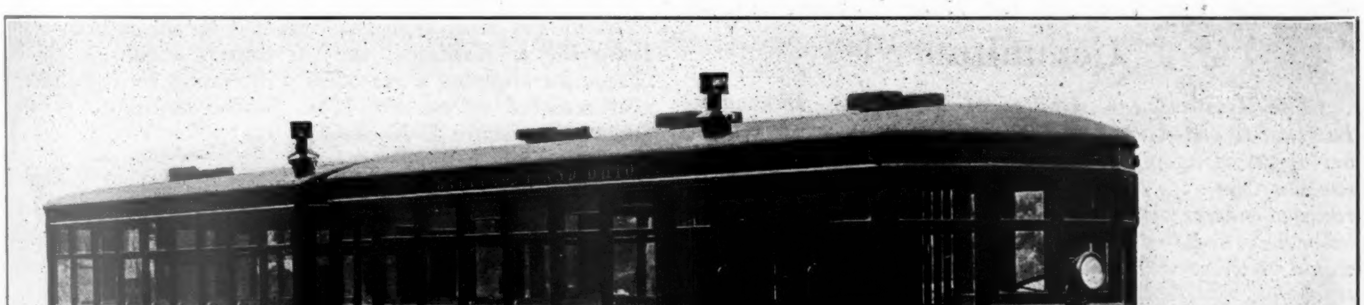
Gasoline Motor Car and Trailer for the Baltimore & Ohio

THE Baltimore & Ohio has recently received from the Edwards Motor Car Company, Sanford, N. C., a gasoline motor car and trailer for use in passenger service on branch lines out of Green Springs, W. Va.

The motor car has a baggage compartment 9 ft. 3 in. long by 7 ft. 8 in. wide just behind the operator's compartment, the rear of the car being fitted with seats for 22 persons. In addition, the trailer has capacity for seating 34 passengers. The cars are equipped with water coolers and toilets. The total weight of the motor car empty is 17,200 lb., and the weight of the trailer empty is 9,350 lb., or a total of 26,550 lb. It is stated that this equipment is lighter per seated passenger than any other of similar type due to the use of heat treated chrome nickel steel and aluminum castings in the construction. On a recent test trip from Baltimore to Philadelphia over the Baltimore & Ohio, these cars made an average speed of 30 miles an hour, the maximum speed being 40 miles an hour.

Both the motor car and the trailer are carried on two four-wheel trucks. The rear truck of the motor car has fixed axles and drives through three chains, two of the chains transmitting the power from the differential shaft, the third chain carrying the drive from the front to the rear axle. It is stated that driving on all four wheels gives unusually good traction and enables the car to run when snow or frost is on the rails. The power to propel the car is furnished by a Kelly-Springfield motor with four cylinders, 4½ in. x 6½ in., which develops 60 hp. at 1,600 r.p.m.

The equipment of the cars includes Westinghouse air brakes, an air alarm whistle, a hot air heating system and 12 volt lighting system. The hot air heaters are of special design with aluminum castings made by the Peter Smith Heater Company, Detroit, Mich. An electric fan is mounted on each heater which drives the hot air through the cars and distributes the heat uniformly.



Edwards Motor Car Unit with Seating Capacity for 56 Passengers

The air brake system is a standard Westinghouse traction brake except that the compressors are of special design made by the Edwards Railway Motor Car Company. There are two compressors, one driven from the line shaft and one from the axle of the rear truck. The compressor driven from the line shaft is used before the car is in motion. It is then cut out and the compressor driven from the axle is used thereafter. Both compressors weigh only 140 lb. and furnish 10 cubic feet of air per minute. An automatic

cut-out device stops the compressors when the required pressure is obtained and a reduction starts them again. These cars are notable for their light weight in relation to

Looking Forward from the Rear of the Trailer

the seating capacity. The motor car weighs 782 lb. per passenger, the trailer 275 lb. and the combined unit 478 lb. per passenger.

Recent Decisions of the Arbitration Committee

(The Arbitration Committee of the A.R.A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, it has been suggested that information in regard to such decisions would be welcomed. The Railway Mechanical Engineer will, therefore, print abstracts of decisions as rendered.)

Settlement for Cars Destroyed in Switching

Alabama & Vicksburg box car No. 22627 was damaged while being switched by the Northern Pacific in its Pasco, Wash., yards, for the Spokane, Portland & Seattle. Northern Pacific accident report dated May 19, 1920, shows that the air brakes on the car were in good operating condition, but not working at the time of the accident, which occurred while the switch engine, in order to place 18 cars on a side track already occupied by 65 cars, was pushing the 83 cars at three miles an hour. The damaged car was the seventy-fourth car from the end. The Northern Pacific requested the Alabama & Vicksburg to prepare and furnish a statement showing the depreciated value of this car. After this had been done the Northern Pacific learned that the car was being handled on behalf of the Spokane, Portland & Seattle, and passed the correspondence to that company in July and the salvage of the broken up car was sent to the home shops of the Spokane, Portland & Seattle at Vancouver. The latter road claims that Rule 32 and the interpretation to Rule 43 should be applied in the settlement of this case. The Alabama & Vicksburg claims that the Spokane, Portland & Seattle should assume responsibility for the net value of the car under Rule 112.

In its decision, rendered November 30, 1921, the Arbitration Committee states that its investigation develops that the body of the car was destroyed and disposed of before the car owner authorized such action, and that settlement should be handled under Rule 112.—*Case No.* 1215, *Spokane, Portland & Seattle vs. Alabama & Vicksburg.*

Settlement for Draft Gear, All Parts Reported Broken

On January 27, 1920, the Indian Refining Company, Inc., received from the Louisville & Nashville a car repair bill in which was included a charge for one Westinghouse friction draft gear, account all parts broken, applied to I. R. C. X. car No. 183. The Indian Refining Company, Inc., took exception to this charge on the ground that in their experience with this type of draft gear after the removal of over 1,000 sets during the past few years, it had never been necessary to scrap an entire gear nor had one ever been found completely broken or defective, and maintained that the Louisville & Nashville charges should be confined to such parts as were defective and broken, in accordance with the decision in arbitration case No. 1062. The Louisville & Nashville's attention was directed to the fact that several such charges as the one in question had been received previously, all of which had been cancelled when brought to that company's attention. The railroad company contends that all parts of the draft gear were broken, as described by the billing repair card, and that the previous cases where similar charges had been cancelled were in no way parallel, inasmuch as neither the billing repair cards nor the original record of repairs showed all parts of the gears broken in those cases, whereas they plainly show all parts broken in the present instance.

The Arbitration Committee decided that as no evidence was presented to indicate that the condition of the draft gear removed was other than that reflected by the records of the Louisville & Nashville, the car owners should accept the charge for applying a gear, less scrap credit for the defective gear removed.—*Case No.* 1216, *Indian Refining Company, Inc. vs. Louisville & Nashville.*

Renewing Packing and Journal Bearings—Cars in Flood

On April 6, 1921, the St. Louis-San Francisco offered to the Midland Valley five cars which had been in a flood. The journal boxes had accumulated mud and sand until it was necessary to renew the packing in all of the boxes. Being unprepared to handle this work at Muskogee, Okla., the St. Louis-San Francisco issued defect cards for these cars, reading "oil boxes full of mud and sand account of flood." The Midland Valley rendered a bill for $117.60 to cover the expense of this work and the renewal of eight journal bearings. The St. Louis-San Francisco objected to the entire charge of $27.60 for renewing journal bearings, on the ground that this work was not covered by the defect cards, and also took exception to the charge for the renewing of packing on these cars, claiming that it should have been made according to item 169-B, Rule 101, 1920 code, at the rate of $3.25 a car, amounting to a total of $16.25. The Midland Valley claimed that the packing was billed at 20 cents a lb., which was the actual cost of preparing it, and that three hours labor was charged for packing the journals on each car, contending that the actual charges should govern since the work was done as an accommodation for the St. Louis-San Francisco.

The Arbitration Committee decided that the charge for renewing the packing should be confined to the amount specified in Rule 101 (1920 code), but that on account of the difficulty of determining the condition of the journal bearings at the time of interchange, the charge for them should be accepted as damage caused by the flood.—*Case No.* 1218, *St. Louis-San Francisco vs. Midland Valley.*

The Santa Fe Has Recently Received **2,500** *of These Cars*

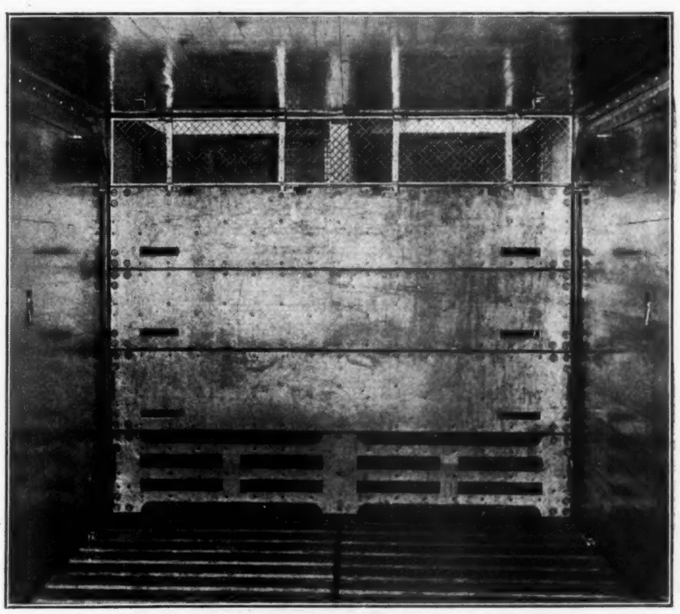
New Designs of Refrigerator Cars for the Santa Fe

Include Two Similar Types, One with Movable, the Other with Stationary Bulkheads

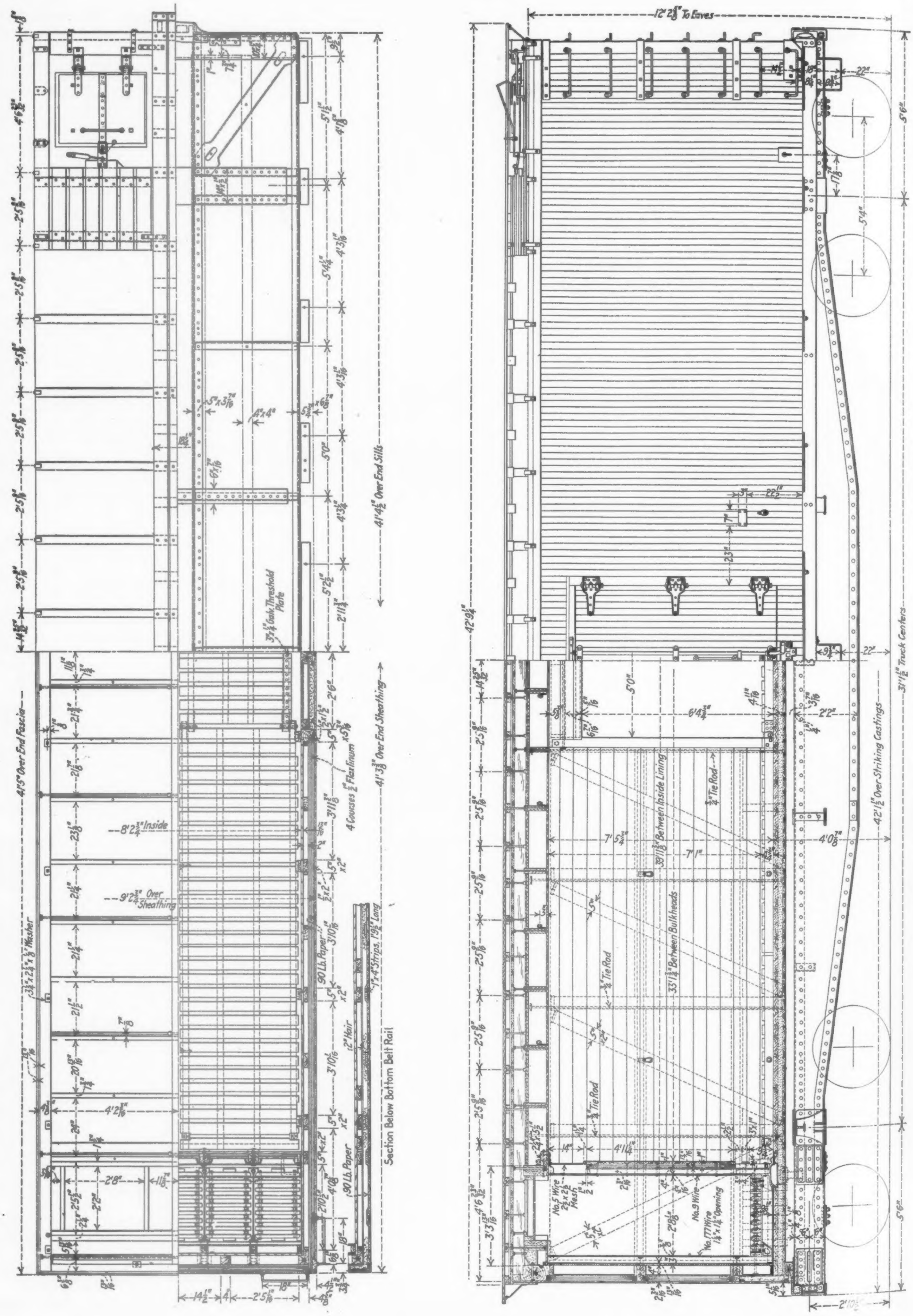
FRESH fruits and vegetables form an important part of the eastbound traffic of the Atchison, Topeka & Santa Fe, and to care for this business the road had in service at the end of 1921, 11,751 refrigerator cars. This is approximately 16 per cent of all the freight cars which the company owns. Compared with this is a total of 32,282 box and furniture cars. Since refrigerator cars form a comparatively large proportion of the house cars, the problem of keeping this equipment in revenue-earning service is important, and the road has followed the practice of loading suitable commodities in refrigerator cars for westbound movement. As the traffic is fairly well balanced, there has been comparatively little empty mileage, in fact it has sometimes been necessary to haul empty box cars eastward.

Bulkhead Sections and Floor Racks Raised to Permit Loading Entire Length of Car Body

In 1920 the Santa Fe needed refrigerator cars and in view of the excess of westward traffic at that time, a design with collapsible bunkers was prepared so that the cars could haul perishables eastward and be loaded to full cubical capacity with box car freight westward. Two thousand five hundred of these cars were accordingly built, half by the

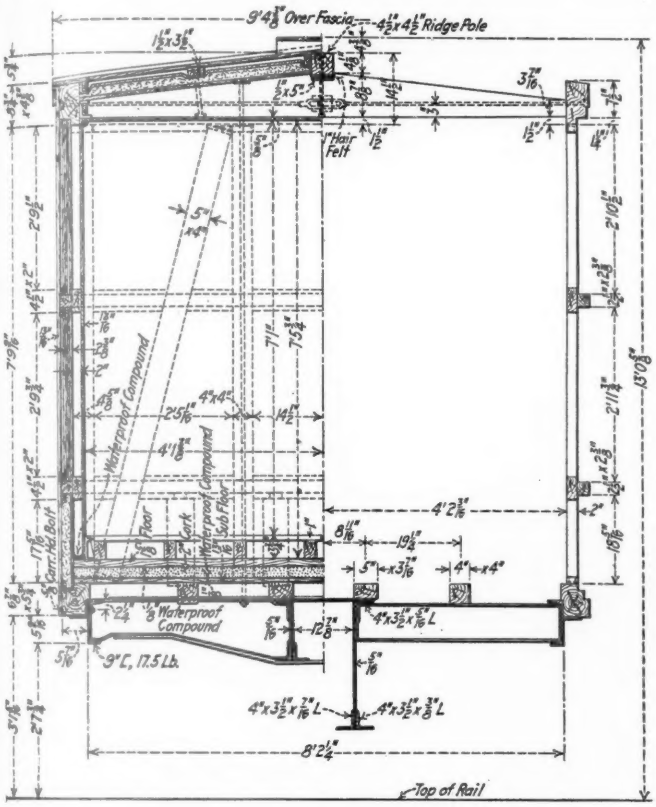


End View with Sectional Bulkhead and Floor Racks Down



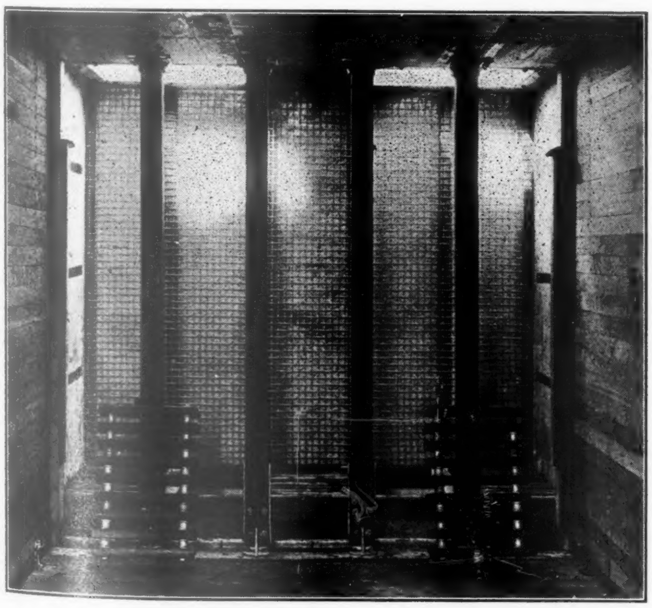
Plan and Elevation of Santa Fe Refrigerator Car with Fixed Bulkheads

American Car & Foundry Company and half by the Haskell & Barker Car Company. In the following year additional refrigerator cars were found to be required. At that time the traffic situation had changed and the box and refrigerator



Sections Through the Car Body

car equipment was adequate to handle the westward movement. The fixed bulkhead was somewhat cheaper and gave a capacity of 1,000 lb. more ice per car and was therefore

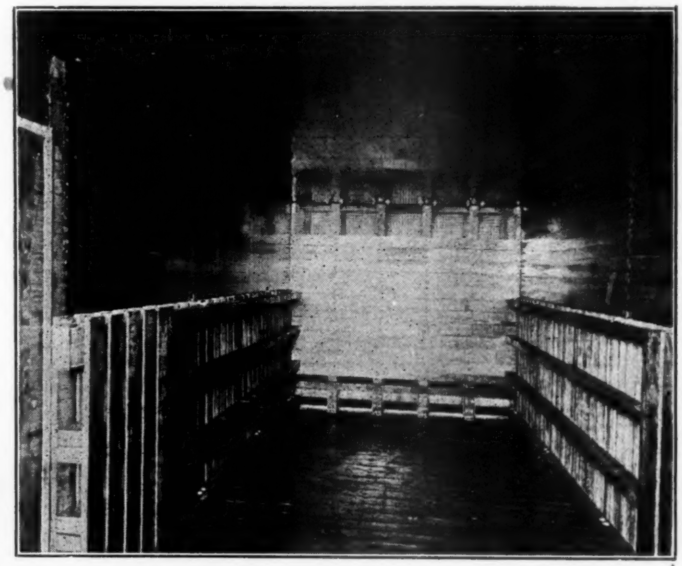


View of Bunker Before Bulkhead Is Applied, Showing Removable Ice Grates

adopted for the later design. An order of 2,500 of these cars, also divided equally between the American Car & Foundry Company and the Haskell & Barker Car Company, has recently been delivered.

Construction of Bunkers and Movable Bulkheads

The movable bulkhead applied to the first order of cars consists of four parts, each built up of 2½-in. boards lined on both sides with No. 20 galvanized sheets. Each section has arched screens on the inside, as shown in the illustration of the bulkhead in the raised position. A movable post is located at the center of the bulkhead to support the sections at that point. The ends of each section of the bulkhead are fitted with trunnions sliding in guides extending up the sides and horizontally just beneath the ceiling. Above the top section and hinged to the ceiling is a screen bound in a channel iron frame. When the screen is down the bulkhead sections are locked, making it impossible to enter the car through the hatches. When it is desired to raise the bulkhead the screen is swung up and secured beneath the ceiling, leaving room for the bulkhead to slide by in the guides to the overhead position. The bulkhead sections when raised are locked in place by gravity catches. The bottom of the bunker is formed by a floor rack hinged to the end so that it can be swung up out of the way when the bulkhead is raised. The back of the ice bunker consists of screens stapled to vertical wooden spacers. A recess is provided between the two center spacers to receive the movable post.



Interior of Car With Stationary Bulkheads; Floor Racks Raised

The sides of the bunker are lined with No. 24 galvanized iron sheets. A locking chain is used to hold the hatch plug down and prevent anyone entering the car through the hatch when the bulkhead is raised. The icebox pans are made of No. 12 galvanized steel with double outlet traps and drains as shown in the drawing.

Stationary Bulkheads

The stationary bulkheads used in the later cars have four intermediate posts, 4 in. by 4 in., and two side posts, 2 in. by 4 in. The tops of the intermediate posts are secured by stirrups, thus avoiding the use of a transverse member which would deflect the air current at the top of the bulkhead and retard circulation. The bottoms of these posts rest on galvanized malleable iron castings which bridge the gutters of the floor pans.

The bulkheads are insulated with two layers of ½-in. Insulite backed by 13/16-in. lining and faced on the outside of the posts by 1-in. shiplapped boards. The inner side of the bulkhead is covered with No. 24 gage galvanized sheets. The top opening of the bulkhead, which is 14 in. high, is covered with a galvanized screen of No. 15 wire, 2½ by

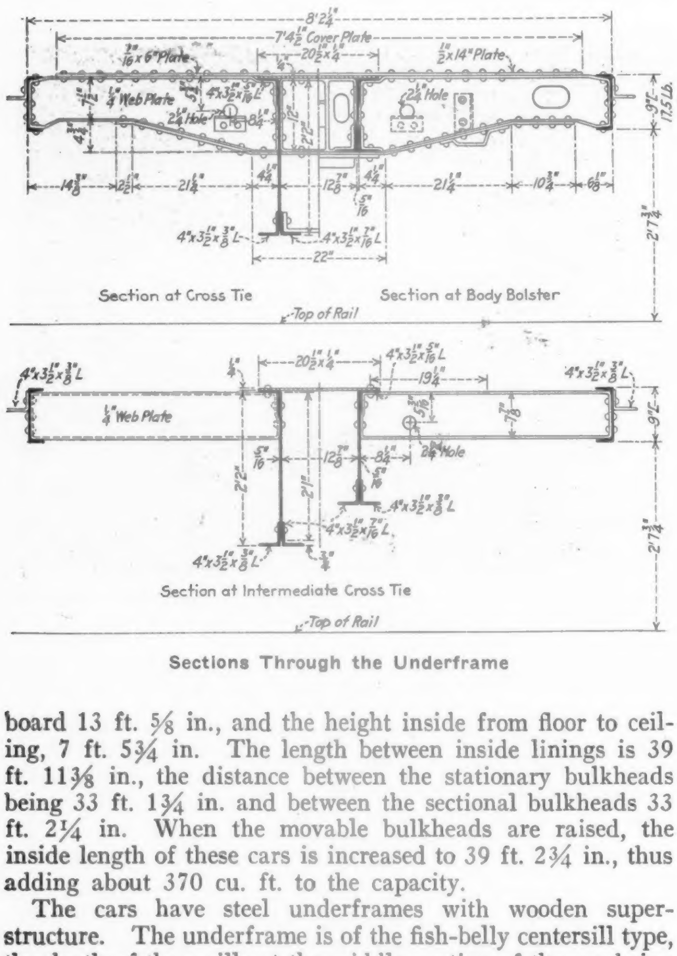
Plan and Elevation of Santa Fe Refrigerator Car with Fixed Bulkheads

2½ mesh to the inch, and a netting of No. 9 wire with .977-in. openings is applied across the inside of the bulkhead posts. The sides of the iceboxes are covered with No. 20 galvanized sheets without netting. The ends of the cars are lined with No. 28 galvanized sheets. Over these sheets 2½ in. by 3 in. wood spacers are applied which in turn hold the netting of .177-in. wire with 1¼ by 1¼-in. openings.

The ice grates are supported on 4½-in. galvanized tee bars at each of the bulkhead posts and by galvanized angles at the sides of the bunkers. The grates consist of 1½ in. by 4 in. oak pieces rounded on the top, joined with rods and malleable iron spacers. The grates can be raised if it is desired to clean the floor pans and if it is necessary to remove the grates, they can be taken out through the hatches. The outlet traps and drains are of the same type used with the movable bulkhead.

General Design

Aside from the arrangement of ice bunkers, these two orders of cars have other interesting details of construction. Both types have the same general dimensions, the length over striking plates being 42 ft. 1½ in.; the width over eaves 9 ft. 4-⅜ in.; the height from rail to top of running

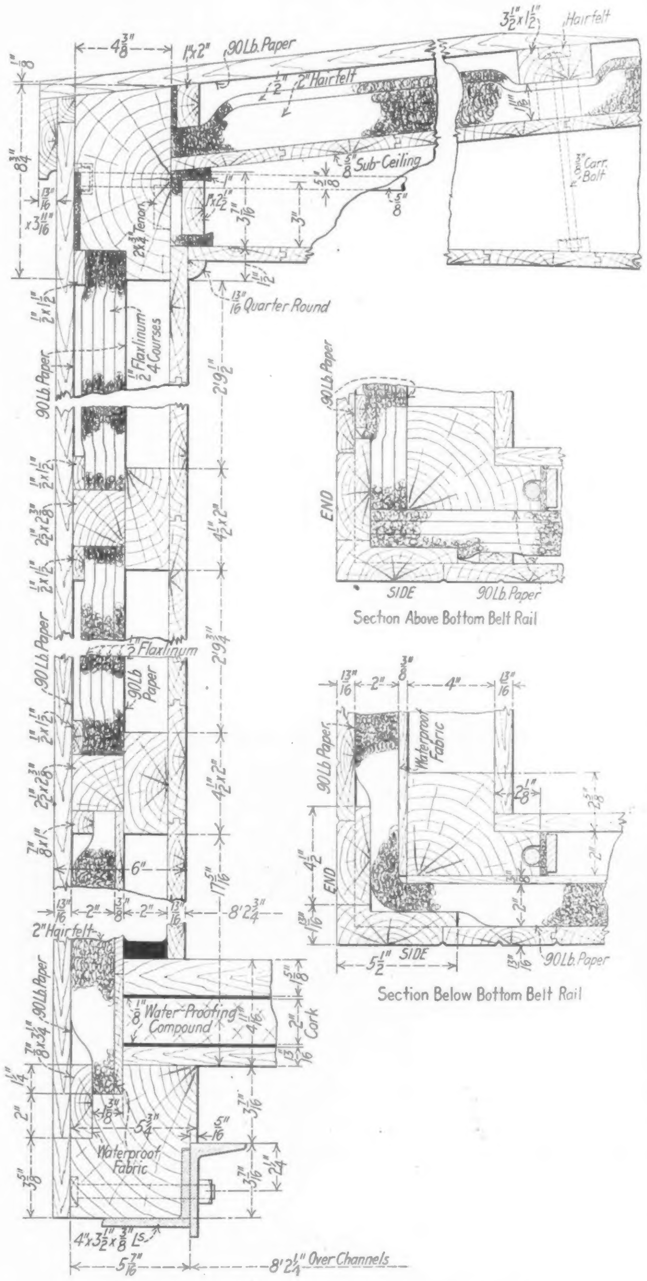


Sections Through the Underframe

board 13 ft. ⅝ in., and the height inside from floor to ceiling, 7 ft. 5¾ in. The length between inside linings is 39 ft. 11⅜ in., the distance between the stationary bulkheads being 33 ft. 1¾ in. and between the sectional bulkheads 33 ft. 2¼ in. When the movable bulkheads are raised, the inside length of these cars is increased to 39 ft. 2¾ in., thus adding about 370 cu. ft. to the capacity.

The cars have steel underframes with wooden superstructure. The underframe is of the fish-belly centersill type, the depth of these sills at the middle portion of the car being 2 ft. 2¼ in. The web plates are 5/16 in. thick and are reinforced at the top by one 4 in. by 3½ in. by 5/16 in. angle on the outside and at the bottom by one 4 in. by 3½ in. by ⅜ in. angle on the outside and by a 4 in. by 3½ in. by 7/16 in. angle on the inside. The sills are reinforced at the top by a 20½-in. by ¼ in. cover plate extending the entire length of the car. The side sills are 9-in. channels weighing 17½ lb. per ft., and the end sills are of the same section. The body bolsters are of a built-up design with cast center fillers and two side diaphragms pressed from ¼-in. steel plate. The diaphragms are spaced 7½ in. between webs and reinforced at the top and bottom by a 14 in. by ½ in. cover plate. There are two main cross ties, each with a single diaphragm of the same section as used in the body bolsters, reinforced by plates on the top and bottom. The three intermediate cross ties are pressed of ¼-in. plate and are of a channel section 7⅞ in. deep. Six longitudinal stringers of fir support the floor.

The construction of the body framing in general follows the usual practice, one novelty being found in the use of



Sections Showing Insulation in Car Body

turnbuckles in the horizontal tie rods at the carlines. These provide a ready means for tightening the framing at this point should it become loose in service.

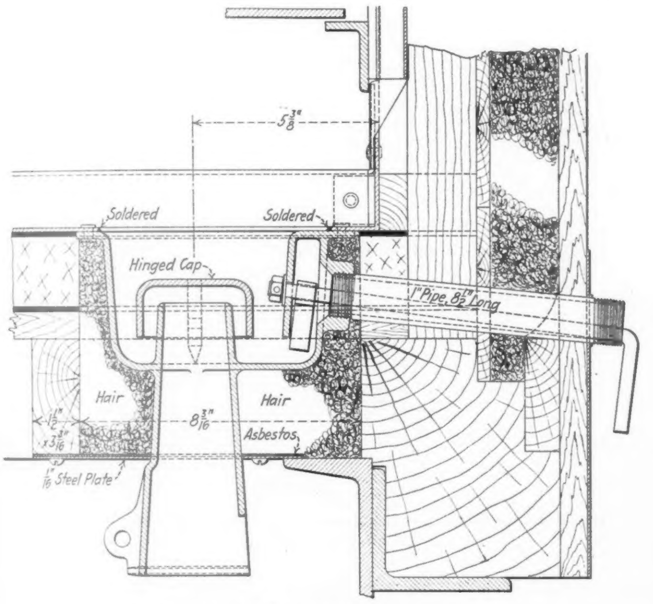
The false flooring which is laid on the floor stringers is 13/16 in. thick. A layer of paper is placed over the false floor and is covered with ⅛ in. of asphaltum. A layer of 2-in. cork board is then laid and is covered with ⅛ in. of asphaltum and one layer of paper before the 1⅝-in. top floor is applied. The floor racks used in both types of cars are the same with supports 3¾ in. high and 1 in. slats.

The sides of the car have 13/16 in. inside lining next to

which is a 2-in. air space. Between the lower belt rail and the side stringers hairfelt insulation is used. A 3/8-in. blind lining is applied which overlaps the floor at the bottom and the lower belt rail at the top. Next to this a layer of waterproof fabric is placed and the hairfelt is then inserted between the fabric and the 13/16-in. outside sheathing. Waterproofing compound is poured between the blind lining and the inside lining to a depth of 3/4 in. over the floor to seal the joints between these parts. Above the lower belt rail the insulation in the sides and ends is made up of four layers of 1/2-in. flaxlinum covered with a layer of paper.

The side of the door opening is 5 ft. 0 in. by 6 ft. 4 3/4 in. The doors are made double with siding on the outside and lining on the inside and with insulation to correspond with that in the sides of the car.

A 5/8-in. blind ceiling is laid over the top of the carlines and hairfelt insulation, held in place by a nailing strip, is applied to cover the joints between the blind ceiling, the lining, the ceiling and the side plate. The 5/8-in. ceiling is then applied under the carlines. The insulation in the



Double Outlet Drain and Trap

ceiling is 2 1/2 in. of hairfelt in one 2-in. and one 1/2-in. layer. The hairfelt is covered with a layer of paper and a 13/16-in. sub-roof is placed over it, supported by the ridge pole and side plate and one intermediate purline. The Standard Railway Equipment Company's outside flexible metal roof, with No. 24 galvanized sheets in the center of the car and No. 20 gage around the hatches is laid over the sub-roof.

The light weight of the cars is 55,000 lb., being practically the same for both designs.

Painting

All parts coming in contact on the trucks and underframes are given one coat of carbon paint before assembling. The finished underframe is painted with three coats of carbon ready-mixed paint and the top of the underframe coated with Lucas car roof cement. The trucks are protected with two coats of carbon paint.

The sides of the car are finished with three coats of refrigerator yellow and the ends with three coats of mineral paint of the Santa Fe standard color. The roof boards, outside flexible metal roof and the hatch covers receive one coat of mineral paint. This is also applied on all tenons and in all mortises on both ends of posts and braces, on shoulders at all tenons and post and brace castings and in all places where two pieces of wood touch each other, except siding, lining, roofing and flooring. All iron fittings of the car receive two coats of paint, the same as used on the trucks and underframe.

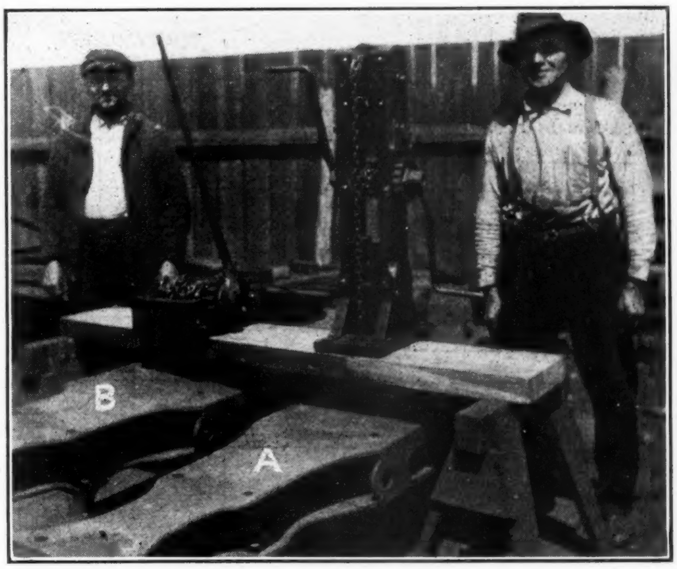
The interior of the sides, the ceiling and all exposed wood in the interior of the car body is painted with three coats of raw linseed oil mixed with an equal quantity of Sipes Japan. All nails are set and puttied after applying the first coat of oil and Japan. The floors are finished with two coats of raw linseed and Japan.

The cars are carried on trucks with 5 in. by 9 in. journals, having Andrews cast-steel truck side frames and cast-steel truck bolsters fitted with the Standard Car Truck Company's lateral rollers. A.R.A. type D couplers with 6 in. by 8 in. shanks are applied, connecting to cast-steel coupler yokes by a transverse key. The draft gear is the Miner friction type A-18-S. The brake equipment is the Westinghouse Air Brake Company's schedule KD-1012. Other specialties applied to the cars include Creco brake beams and Imperial uncoupling arrangement.

Car Bolster Lifting Device

An interesting labor-saving device used at the Chesapeake & Ohio shops, Huntington, W. Va., is shown in the illustration. It consists of a windlass (two forms of which are illustrated) used for applying or removing car body bolsters rapidly and easily and with greater safety than would be possible with ratchet jacks. The usual method of performing this work is to raise a bolster into place beneath the car by means of jacks, the workmen who apply or remove the bolts being in more or less danger unless great care is taken in placing the jacks.

The men shown in the illustration are Chesapeake &



Easy and Safe Method of Lifting Car Bolsters

Ohio employees who, among other labor-saving devices, have developed the method shown for raising car body bolsters. The operation consists of lifting the bolster by means of a windlass within the car, the windlass chain passing through a hole in the floor and being fastened to the bolster. Operation of the windlass will then raise the bolster into place beneath the car where it is held firmly while holes are being bored and bolts applied. There are no jacks to interfere with the work or by slipping endanger the workman who may be under the bolster. Any form of windlass may be used, two of the more common kinds being shown in the illustration raising the bolsters *A* and *B*.

Thermal Stresses in Chilled-Iron Car Wheels

Tests to Determine Effect of Heating Due to Brake Application Conducted by Bureau of Standards

A PAPER recently issued by the Bureau of Standards describes tests to determine thermal stresses in car wheels conducted by G. K. Burgess and R. W. Woodward in the laboratory under conditions approximating those encountered when heavy brake applications are made in descending long grades. The wheels were heated by passing an electric current through a band of iron encircling the tread. The resulting stresses were calculated from strain gage measurements after correcting for thermal expansion. Twenty-eight wheels of varying weights and designs from three manufacturers were tested in this manner, of which 16 failed by cracking in the plate. The maximum stresses developed were found to be close to the tensile strength of the cast-iron and to occur in a radial direction near the junction of the double plates in the M.C.B. or Washburn type of wheel. In the arch-plate type the maximum stress is somewhat nearer the hub. An abstract of the complete report is given below.

Chilled-Iron Wheels Have Long Given Satisfactory Service

For over half a century most of the freight cars in use in this country have been equipped with chilled-iron car wheels. The process of manufacturing does not differ fundamentally from that of 50 years ago. Along with improvements in the process of manufacture, there have been redistributions of the metal and changes in design. Perhaps the chief factor toward enabling the chilled-iron wheel to

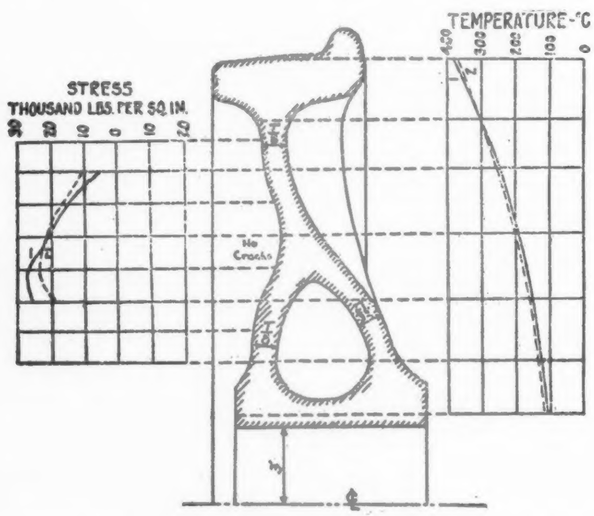


Fig. 1—Cross Section and Stress and Temperature Gradients for 625-lb. M.C.B. Type Wheels

meet operating conditions was the adoption of standard designs. As a result the percentage of failures, when considering the number of wheels in service, is less today than it was before the adoption of the standards and has been growing less while operating conditions have become more severe.

Chilled-iron wheels have given general satisfaction, even under the present existing conditions of greater speeds and heavier wheel loads. Occasional failures occur at the foot of long, steep grades caused by prolonged brake application at high speed. The effect of long continued application of brakes is to heat the tread of the wheel to high temperature while the hub remains relatively cool. These variations in temperature induce stresses and strains of varying amount within the wheel. When the temperature difference becomes great enough the wheels will crack and occasionally break. One of the large railroad systems found that in a period of seven months approximately one-fifth of their wheel failures were due to the effects of brake application.

General Plan of Investigation

Although the number of failures of chilled-iron car wheels is relatively small, yet they are of sufficient importance to warrant investigation of strains and stresses. The investigation conducted by the Bureau of Standards was restricted to the problem of determining the manner in which the

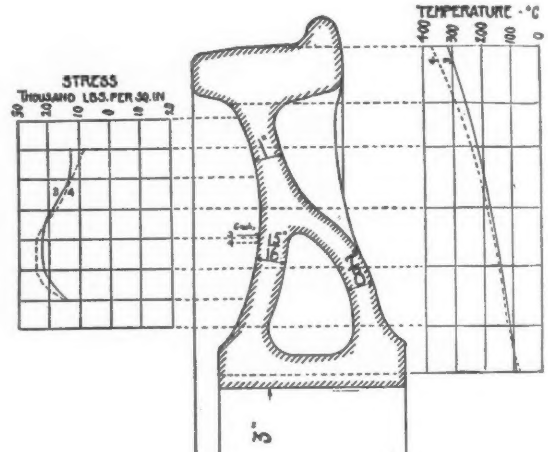


Fig. 2—Cross Section and Stress and Temperature Gradients for 700-lb. Arch-Plate Type Wheels

thermal stresses build up and the relative ability of the various weights and types of chilled-iron wheels to withstand the effects produced by temperature gradient within the wheel.

Fifty wheels were used in the investigation, and in order to make the tests general the wheels were furnished by three different manufacturers, designated A, B, and C. Each manufacturer was requested to supply four wheels of each weight or type which he wished to submit. One of these was used for drop and one for thermal tests (American Railway Association Specifications) at the works of the manufacturer and the remaining two wheels for special bureau thermal stress tests. The drop and thermal tests made at the foundries were of the usual type required by current specifications. Manufacturer A cast wheels for the special Bureau of Standards tests only, but the others provided wheels for all tests.

Designs and Weights of Wheels Tested

Three types of wheels were tested in this investigation, namely, the Washburn, arch-plate, and single-plate types. A cross sectional drawing of the Washburn, commonly called the M. C. B. type, is shown in Fig. 1. In Figs. 2 and 3 are shown, respectively, the arch-plate and single-plate types. The M. C. B. was the standard shape adopted by the Master Car Builders' Association in 1909, and although many of this type are still in service it has been replaced by and all renewals are of the arch-plate type. The present M. C. B. standard wheels are of the arch-plate design and weigh 650, 700, 750, and 850 pounds for cars of 30, 40, 50, and

70 tons, respectively. The single-plate type (Fig. 3) is a special experimental design and is not at present used by any railroad.

All the wheels subjected to the drop test—namely, four from manufacturer B and seven from manufacturer C—gave satisfactory results. The wheels from these two foundries were submitted to the usual thermal test and also met the requirements of the specification.

Method of Procedure for Thermal Stress Tests

In the special thermal stress tests the wheel was mounted on a hollow water-cooled 6-in. axle. The axle in turn rested upon cast-iron and concrete supports. A soft-steel resistor

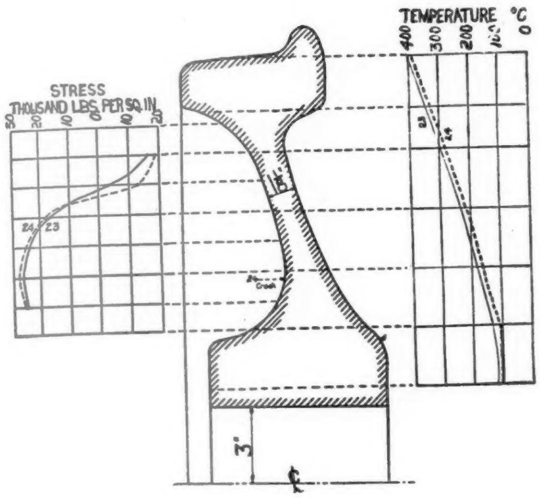


Fig. 3—Cross Section and Stress and Temperature Gradients for 750-lb. Single-Plate Type Wheels

3½ in. in width and ¼ in. in thickness was placed on the tread of the wheel, but insulated from it by a thin sheet of perforated asbestos, and an alternating current of 1,000 to 1,500 amperes at 15 to 30 volts was passed through the resistor. As the wheel was in an upright position and remained stationary throughout the test, it was readily possible to take such observations as necessary.

The tread of the wheel attained a maximum temperature of approximately 380 deg. C. (716 deg. F.) in each experimental run. To determine satisfactorily the distribution of temperature in the wheel from tread to hub copper-constantan thermocouples of No. 30 B. and S. gage wire were used, seven couples along a vertical radius at approximately 2-in. intervals and seven others similarly located along the horizontal radius (Fig. 4). Readings were taken along both radii for the purpose of obtaining duplicate results. Two other thermocouples were inserted into the treads of the wheel. Thus, four couples, one at the gap in the resistor, were placed at equidistant points in the tread of the wheel and assurance given that uniformity of tread temperature was attained.

A 2-in. Berry strain gage was used for measuring the deformation, six sets of readings being taken at 1-in. intervals on both the vertical and horizontal radii.

It was only necessary to take a survey of the stresses on the plate side of the wheel (outside as mounted on axle), since preliminary measurements had shown that the stresses on the bracket side of the wheel were of a compressive nature and of relatively small magnitude.

Identical rates of power input were maintained for each test in order to obtain comparative results. It was necessary to increase the power input near the end of the test to attain the desired tread temperature in a comparatively short time. The rate of heat input in these tests was considerably more severe than that found in normal operating service.

The power input was not uniformly applied. The amount applied per minute during the different periods of the test was as follows:

First half hour..........................	570,000 ft. lb.
Second half hour..........................	690,000 ft. lb.
Third half hour..........................	770,000 ft. lb.
Fourth half hour..........................	797,000 ft. lb.

Table No. I gives an approximate comparison between the work performed on the test wheels and the energy required to hold a train at a constant speed on descending grade. This table shows the brake work per wheel in millions of foot-pounds per mile for cars of various capacities and grades up to 4 per cent.

TABLE I*—BRAKE WORK PER WHEEL PER MILE (IN MILLION FOOT-POUNDS PER MILE†) FOR CONSTANT VELOCITY ON VARIOUS GRADES FOR VARIOUS CAR CAPACITIES AND WHEEL LOADS

Car capacity	60,000	80,000	100,000	120,000	140,000	160,000	180,000	200,000
Max'm wheel load (tons)	6	8	10	11.25	12.5	14.75	15	16.25
Grade (per cent):								
1......	0.38	0.51	0.63	0.71	0.79	0.87	0.95	1.03
2......	1.01	1.35	1.69	1.90	2.11	2.32	2.53	2.75
3......	1.65	2.20	2.75	3.09	3.43	3.78	4.12	4.46
4......	2.28	3.04	3.80	4.28	4.75	5.23	5.70	6.18

*This table is, in part, due to F. K. Vial, consulting engineer, Association of Manufacturers of Chilled Car Wheels.

†An allowance of 8 lb. per ton has been made for train resistance.

It is apparent from the above table that 630,000 ft. lb. of energy are destroyed per minute by the brake on each wheel

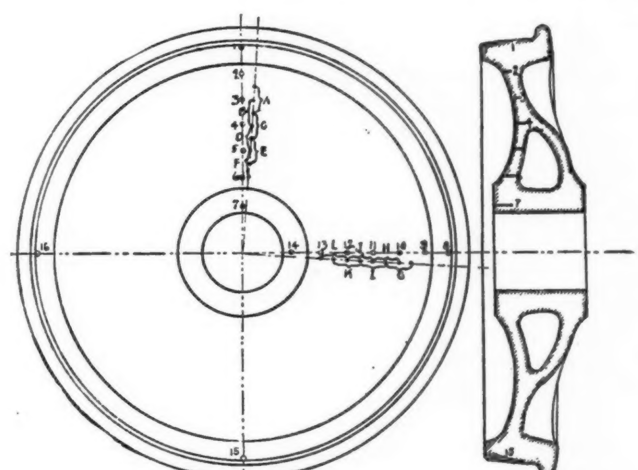


Fig. 4—Sketch Showing Location of Thermocouple and Strain-Gage Holes

of a 100,000-pound car in maintaining a constant velocity under the following operating conditions: Descending a 1 per cent grade at 1 mile per minute, or 60 miles per hour; 2 per cent grade at 1 mile per 2.68 min., or 22 miles per hour; 3 per cent grade at 1 mile per 4.37 min., or 13 miles per hour; 4 per cent grade at 1 mile per 6.03 min., or 10 miles per hour. However, the actual test conditions were more severe than these figures indicate on account of the difference in the heat dissipation in the two cases.

In the bureau tests the treads of the lightest wheels reached a temperature of 380 deg. C (716 deg. F.) in about 75 minutes, while it required from 100 to 105 minutes for the heaviest wheels to reach the same temperature. Readings were taken of the temperature, strain, and power input at regular intervals, a strain gage reading of the cold wheel being also taken before the test was started. Temperature and strain gage readings were also taken during cooling and after the wheel was at room temperature.

The elongation as determined by the strain gage is attributable to two causes: (1) An elongation due to the thermal expansion of metal, and (2) elongation caused by the strain due to the temperature gradient from tread to hub of the wheel. By knowing the coefficient of expansion and the temperature rise it was possible to calculate the thermal expansion. By deducting the elongation due to this expansion

from the total elongation the elongation due to stress alone was determined. The relation between stress and strain on samples actually taken from the wheels made it possible to convert the strain readings into stress values.

Properties and Composition of Material

The coefficient of expansion for the range from 68 deg. F. to 590 deg. F. was determined on specimens cut from one of the wheels furnished by each of the three manufacturers. The composite expansion is given in Table II.

TABLE II—THERMAL EXPANSION OF WHEEL SPECIMENS

Temperature Rise		Total Expansion in Inches per Inch
Deg. F.	Deg. C.	Composite
90	50	0.00055
180	100	.00113
270	150	.00175
360	200	.00241
450	250	.00311
540	300	.00384

The mechanical properties of the material were determined on specimens of 8-in. gage length taken from the plates of the wheels at right angles to the radius. For the purpose of computing the stress values in the heated wheels the modulus of elasticity is required. Since cast-iron has no such constant modulus when tested in tension, the stress-strain curve was determined up to as near the rupture as possible and then extrapolated to rupture by the data obtained for the elongation and ultimate strength. These curves for the wheels of the three manufacturers are shown in Fig. 5. Table III shows the average results for the tensile tests. The chemical composition is shown in Table IV.

TABLE III—AVERAGE RESULTS OF TENSILE TESTS

Manufacturer	Apparent elastic limit Lb. per sq. in	Ultimate strength Lb. per sq. in.	Elongation in 8 inches Per cent	Reduction of area Per cent	Modulus of elasticity at "zero stress Lb. per sq. in.
A............	9,600	26,700	0.8	0.3	17,300,000
B............	6,300	18,900	.8	.4	15,400,000
C............	11,000	27,000	.8	.4	18,400,000

TABLE IV—RANGE OF CHEMICAL COMPOSITION IN TEST WHEELS

	Per cent
Total carbon	3.14 –3.70
Graphitic carbon	2.49 –3.06
Combined carbon	0.31 –0.77
Manganese	0.52 –0.77
Silicon	0.54 –0.87
Phosphorus	0.28 –0.41
Sulphur	0.109–0.185

Although the chemical composition of the wheels is of interest, it is thought to be undesirable to attempt to correlate so few compositions in terms of the behavior of the wheels.

The measurements of strain in the wheel are subject to a possible error of plus or minus 0.0002 in. per inch. This corresponds to an error in stress of plus or minus 4,000 lb. per sq. in. for low values of stress, but for higher values would be considerably less, or about 400 lb. per sq. in. It is a fair assumption that the possible error throughout the major range of the stress measurements is plus or minus 3,000 lb. per sq. in.

Results of Thermal Stress Tests

Stresses.—It was found in the tests that an unexpectedly large number of the wheels developed cracks in the plates. These cracks were circumferential in nature and were all approximately at the same distance from the center of the wheel, namely, 9 in. Of the 28 wheels 16, or 57 per cent, developed cracks in the plates. Some cracks were barely perceptible, others almost completely encircled the wheel.

For the 28 wheels which were used for thermal stress tests at the bureau computations were made which showed the stresses existing in the wheels at each of the strain-gage positions. The magnitude of these stresses in typical wheels is shown in Figs. 1 to 3, where they are plotted against their relative positions along the radius of the wheel. These curves indicate the stresses existing in the wheel at the time of failure of the wheel by cracking or in the event the wheel did not crack at the time the maximum temperature gradient existed between tread and hub. The temperature distribution at the same time is also shown in a similar manner.

Of the six wheels submitted by manufacturer A, wheels 3 and 4 developed slight cracks, while the remaining four wheels showed no evidence of failure. The maximum stresses in the wheels submitted by manufacturer B are considerably lower than those in the wheels submitted by either manufacturer A or C. Three of the eight wheels developed cracks in the tests. With the exception of Fig. 3, the stress distribution in wheels furnished by manufacturer C is of the same general character as in the other wheels tested. In the single-plate wheel, as shown in Fig. 3, the stress distribution is decidedly different than it is in the other types.

The single-plate type of wheel is a special experimental design and is not used by any railroad. It was thought that this type of wheel might show greater ability to withstand operating conditions.

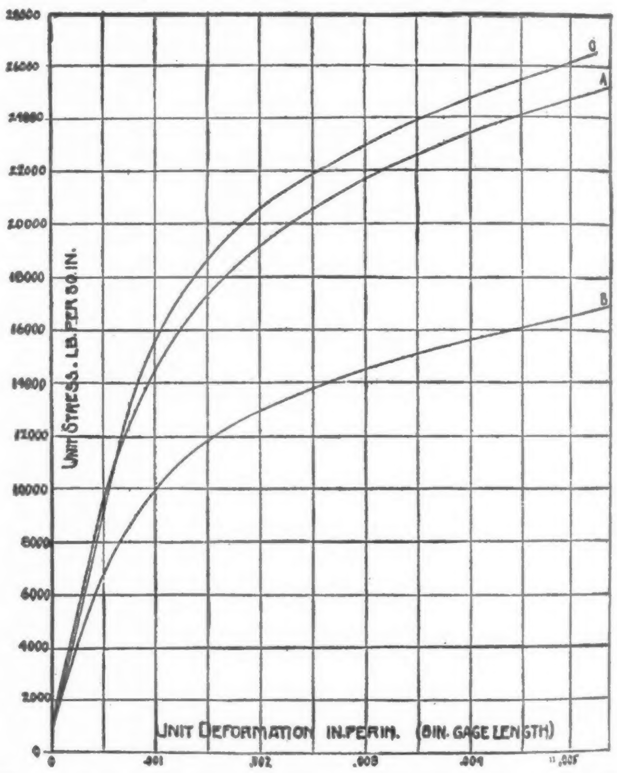


Fig. 5—Composite Stress-Strain Curves Obtained from Tensile Test on Samples of Cast-Iron from Wheels of the Three Manufacturers

Although this wheel showed higher strains and hence stresses for a given heat input than the M. C. B. and arch-plate types, yet the distribution is such that when subjected to additional stress-producing factors, such as mounting, static load, and flange pressure, it seems probable that the strain or stress under those conditions would be less than in either the M. C. B. or arch-plate designs. For instance, the compression found near the rim on the outer face through heat application may be increased slightly when the static load is added, but the addition of the flange pressure or side thrust would more than offset this addition, so that the net effect would be a reduction in the strains or stresses found. The tension unquestionably present on the inner face near the rim would similarly be reduced. Further, the magnitude of the tensile strains or stresses found in the hub region would be counteracted by compression resulting from mounting the wheel onto its axle. Both of the wheels of this type withstood the thermal and drop tests as required by the M. C. B. specifications. In view of these facts the results indicate that the single-plate design, although it does not withstand the

special thermal test made by the bureau as well as the M. C. B. and arch-plate types, yet may possibly be better adapted to service conditions.

The highest maximum stress measured was 28,400 lb. per sq. in., while the lowest stress at which failure occurred was 14,000 lb. per sq. in. It is possible that the latter wheel had an internal flaw which accelerated the failure. The maximum stresses observed are in nearly all cases very close to the ultimate strength of the cast iron of which the wheel is composed. Thus, for manufacturer C the stresses are in the neighborhood of 26,000 lb. per sq. in., and this material was shown to have a tensile strength of 27,000 lb. per sq. in. The wheels from foundry B usually showed stresses around 17,000 lb. per sq. in., while the tensile strength was about 19,000 lb. per sq. in.

Relation of Weight to Strain.—To show the relative ability of different weights of the arch-plate type wheel to withstand the effects of temperature gradients, a comparison was made of the unit strains due to internal stress 40 min. after the start of the tests. The unit strains at that time were averaged for each of the types tested. Then, by using the average unit strain as found in the 625-lb. M. C. B. type of wheel as a basis for comparison, the relative average strains at the end of 40 min. of heating are given in Table V. It is evident that the 850-lb. M. C. B. (arch plate) was best able, while the 750-lb. single plate was least able to withstand the special bureau thermal test. In the case of the single-plate wheel this does not necessarily indicate that this type would be least satisfactory in service, as was indicated above. By plotting the average unit strain against the weight of wheel for the arch-plate pattern the effect of the additional weight becomes apparent.

TABLE V—RELATIVE AVERAGE STRAIN AFTER 40 MIN. OF HEATING

Type of wheel	Relative average strain
625-lb. M. C. B.	100
625-lb. arch plate	100
650-lb. arch plate	113
700-lb. arch plate	80
725-lb. M. C. B.	90
750-lb. single plate	117
775-lb. arch plate	67
850-lb. arch plate	60

It is felt that the curve gives a fair approximation of the effect of additional metal in withstanding the effect of thermal gradients. Taken from the curve their relative strains are as follows:

Arch plate type	Relative strain
625-lb.	100
650-lb.	86
700-lb.	69
775-lb.	57
850-lb.	51

The curve indicates further that a certain amount of metal does more good when added to the lighter weight than it does when added to the heavier weight wheels. The total number of wheels tested is too small to draw any definite conclusions, but the results seem to point to the following generalities, which should be confirmed by a greater number of tests:

1. The method used was such that the heat input to the wheel was much greater than that which would enter a wheel doing its proportionate part in taking any car down any grade found on trunk-line railroads at a reasonable speed.

2. The rate of heating in the special thermal test as conducted by the bureau was more severe than actual service conditions, so that wheels which stand up under the foregoing tests will not fail under the extreme conditions of a long and heavy application of the brakes. These special thermal tests, however, are not as severe as the thermal test required by the M. C. B. specifications, in which for rejection a wheel must crack through the rim in two minutes. In the tests here reported no wheels cracked through the rims, although a large number developed cracks in the plates.

3. The maximum stresses developed are very close to the tensile strength of the cast iron and are some function of the strength of the iron.

4. Preliminary tests show that the stress in a tangential direction on the outer face and also the stress in both the radial and tangential direction on the bracket side of the wheel are relatively small when compared to those in a radial direction on the outer face of the wheel.

5. The maximum tensile stresses occur in a radial direction near the junction of the double plates in the M. C. B. or Washburn type of wheel. In the arch-plate type the maximum stress is somewhat nearer the hub. This seems a desirable condition in that it then lies in the region where it is counteracted by the strains due to forcing the wheel onto its axle.

6. The tests also lead one to believe that the operating conditions to which wheels are subjected may be as important a factor in the safety of the wheel as are the problems arising in their manufacture.

7. By proper distribution of metal in the single-plate type of wheel there would appear to be a possibility of securing a wheel more capable of meeting service requirements.

8. With identical rates of heat input the heavier-weight wheels withstand the effect of tread heating with less strain than the lighter wheels. It seems conceivable, however, that a wheel may be made where increased weight will not aid the wheel to withstand brake application. Such weight, however, is beyond the weights in use today.

The Education and Duties of Car Inspectors*

By H. H. Harvey, General Car Foreman, C., B. & Q.

THE selection and training of car inspectors is one of the real problems of a car foreman. The car inspector has to make quick decisions, and much depends on his judgment, as no set rules can be laid down to cover each particular case he must handle.

The character of inspection is hardly the same at any two points, even on the same railroad. In general, however, it may be classified under the several heads here discussed.

Terminal Inspection of Passenger Cars

This is probably the most important of all inspections, as the safety not only of his fellow employees but of the public as well, depends on the thoroughness with which the inspector performs his duties.

At larger terminals the inspection of passenger cars is sub-divided. Inspection of trucks, draft rigging, brakes and parts underneath the car is usually made by men known as truck inspectors. It is of prime importance that this class of work be done in the most thorough manner, as any oversight may result in a serious accident, with possible loss of human life.

Truck inspectors should be well posted as to the requirements of their own road as to what classes of cars are permitted in each train, and should see that cars not complying with these requirements do not get into trains from which they are barred.

Foremen should impress on truck inspectors the need for being constantly on the lookout for loose wheels or tires, cracked wheels or tires, worn out or slid flat wheels, defective axles, hot boxes, worn or cracked truck or brake hangers and pins, missing pins, nuts or cotters, cracked equalizers, pedestals out of line, weak or broken bolster springs, equalizer springs that bottom, worn out or cracked brasses, worn out, broken or cracked brake parts, cracked couplers or parts, couplers or parts worn below the limit of safety, cracked or worn coupler pockets, rivets or pins, low couplers and any defects in trucks, brakes or draft rigging. These are the

* A paper read before the Car Foremen's Association of Chicago on May 8, 1922.

vital parts that have to do with the safety of the car, and inspectors should be trained always to take the safe side when passing judgment on them.

Inspectors who look after air brakes, heating and lighting of cars should be trained as to their particular line of work, and whenever any new device or system comes out, foremen should discuss it with their inspectors and explain in what way it differs from others they are familiar with.

The platforms, vestibules, body and interior of cars are usually looked after by men known as body or equipment inspectors. They should be trained to see that windows and fixtures are in safe and operative condition, as personal injuries may result from defective fixtures, especially window locks that permit windows to drop when in the open position. Water systems and basin and hopper fixtures should be tried out on each individual car. It is a great annoyance to passengers if these parts are defective or inoperative. Seats and fixtures should be kept in good condition, with no loose or protruding screws on which passengers might tear their clothing.

These inspectors should also be trained to see that side, end, vestibule and trap doors are kept in first class condition so that they will operate easily, and that defective or missing locks, staples, chain bolts, barrel bolts, end door bars, door hasps, door fasteners, etc., are promptly repaired, particularly on mail and express cars. They should be taught the requirements of the Post Office Department as to the loose equipment called for in mail and compartment cars, the heating, lighting and sanitary requirements of the Department, and any special state laws affecting these matters.

Foremen are held responsible for the work of their men, and it is a part of the foreman's duty to see that only men of proper calibre are assigned to the inspection of passenger cars. He can render no more efficient service to his road than in properly training the inspectors under him.

Intermediate Inspection of Passenger Cars

Foremen at intermediate passenger train inspection points should train their inspectors to be on the constant lookout for hot boxes, cracked or loose wheels or tires, sticking brakes and any defects in trucks, brakes or draft rigging that may have developed enroute. The inspectors should be drilled in methods of making emergency or quick repairs to hot boxes, broken train lines, broken bottom rods and hangers, steam heat defects, air brake defects, and electric light and gas troubles. This training is too often neglected by foremen and as a result, when an emergency arises an important train may be delayed longer than would have been the case had men been taught how best to handle such cases quickly.

Interchange Inspection of Freight Cars

Interchange inspectors should be thoroughly familiar with that part of the interchange rules which has to do with the interchange of cars, loading rules, safety appliance requirements and the rules of the Bureau of Explosives affecting their work. A foreman is expected to be familiar with all of these rules, and it is a part of his duty to know that his inspectors have a reasonably good working knowledge of them.

Local meetings at which the rules are discussed are almost a necessity; they serve not only to educate the inspectors but tend to keep the foremen better posted. Occasional examinations should be held, either written or oral, and questions asked should be really practical ones. Too often meetings that should be of great benefit to those in attendance accomplish very little because some one brings up a technical question, which may never come up in actual operation, the discussion of which takes up a great deal of time and crowds out questions that could be profitably discussed; as a result everybody goes home feeling that their time has been wasted. My personal opinion is that more practical benefit will result from an oral than from a written examination. Furthermore, we should conduct them, not with a view of finding out how much an inspector does not know, but rather to awaken his interest and help him to learn more about the rules under which he is working.

Terminal and Division Point Inspection of Freight Cars

This inspection should be made to insure that loaded cars are in a reasonably safe condition to carry the load to destination without having to be set out enroute, and that empty cars are in proper condition to load. These requirements vary on different roads, and in fact on different parts of the same road.

Inspectors at these points should be trained as to the requirements of their particular road and the work should be handled in a manner similar to that outlined under the heading "Terminal Inspection of Passenger Cars." These inspectors should be trained along the same lines as interchange men, except that possibly men who do no interchange work do not require so thorough a knowledge of the A. R. A. Interchange Rules.

Inspectors located at freight houses, on team tracks and at elevators should be specially trained on the importance of getting side door fasteners in condition so that doors can be properly closed and properly sealed to prevent pilferage.

Safety Inspection of Freight Cars at Intermediate Points

This heading is self-explanatory and Inspectors at intermediate points should be trained to look principally for only such defects as may render cars unsafe to go forward to the next division point. They should be instructed as to the quickest and best way to make emergency repairs in order to avoid undue delays to trains.

In conclusion, would suggest that foremen read carefully the bulletins gotten out by the Bureau of Explosives, and discuss with their men the methods suggested as to precautions for preventing fires and explosives in case of wrecks or other accidents, as well as the best methods of handling fires caused by leakage of acids, gasoline, etc. This is a matter worthy of a great deal of study.

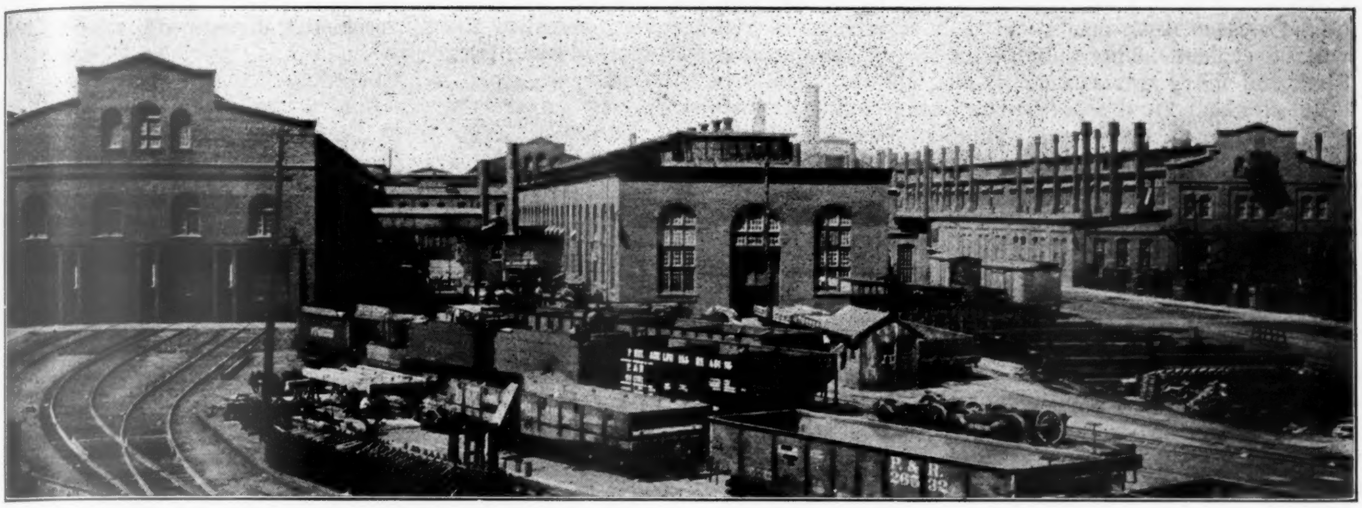
Discussion

Several of those who took part in the discussion commented on the value of meetings at which the application of the rules of interchange and other problems of the car inspector are discussed. Such meetings, wherever they have been conducted, have met with an immediate response, not only from the inspectors but from car repairers and apprentices, and the foremen have been as much benefitted as the men.

A number of roads are using some form of examination for car inspectors. On the Baltimore & Ohio, a list of 79 questions is submitted to these men, who have them to study for 30 days before they are required to submit their answers in writing. The opinion was voiced by several who spoke, however, that written examinations are of little value as a means of measuring the ability of an inspector because some of the inspectors with the best judgment are the least able to express themselves in writing. Here, it was pointed out, was one of the opportunities for the holding of meetings, in which the discussions stimulate the men to improve their knowledge, while the written examination may prove to be a discouraging factor.

The car men's agreements on several roads have been negotiated to include a provision requiring that men promoted to inspectors must be able to read and write the English language. In at least one case mentioned, it is further required that these men must know the first four rules of arithmetic.

The freedom from trouble from the work of inspectors at outlying points as compared with those at the large terminal yards or shops was the subject of comment. In explanation it was suggested that these men were forced to depend on their own judgment and therefore developed more independence than men working under closer supervision.



Philadelphia & Reading Locomotive Shops and Foundry at Reading, Pa.

High Points at Reading Locomotive Shops

Striking Features of Machine, Blacksmith, Boiler and Erecting Shop Work Are Described in Two-Part Article

Part I

As a background for the following description of locomotive shop work, it should be remembered that the Philadelphia & Reading owns 1,093 locomotives and slightly over 43,000 cars, practically all heavy locomotive repairs and a considerable proportion of car repairs being made in extensive repair shops located at Reading, Pa. Obviously this large concentration of work at a single point

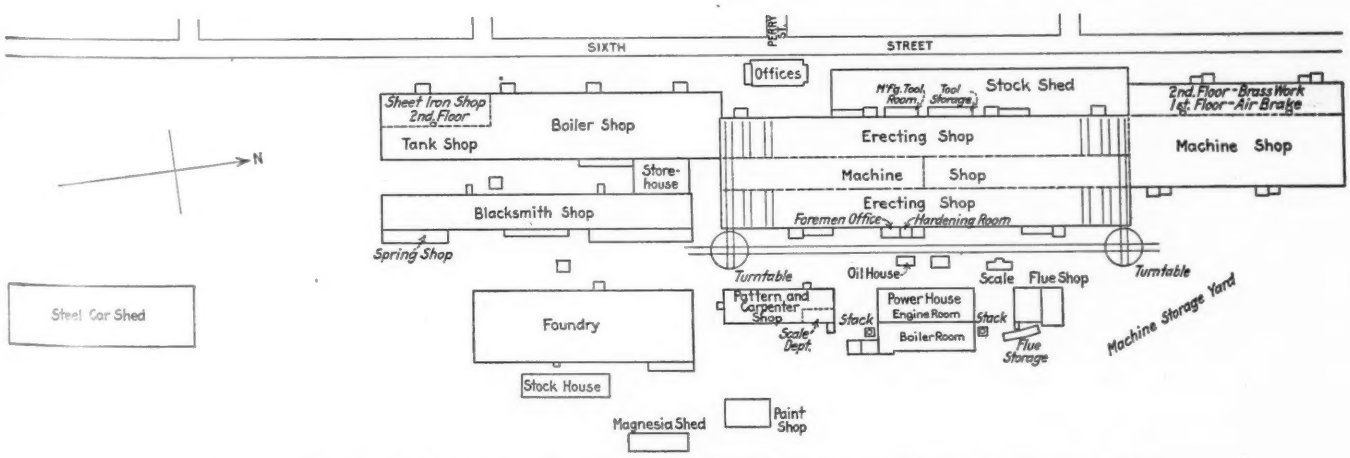


Fig. 1—Diagram Showing the Location of Various Departments of the Reading Locomotive Shops

results in certain important advantages such as relatively low cost of supervision, quick communication between departments, and the use of production machinery and methods which would not be warranted in a shop of small capacity. The work at Reading shops is performed under the supervision of I. A. Seiders, superintendent of motive power and rolling equipment, and W. L. Rice, superintendent of shops, through whose courtesy the photographs, drawings and data used in this article were obtained.

In 1921 a total of 771 locomotives were given heavy general repairs at Reading and 20 new ones built, including five Pacific type, five Atlantics and ten switchers. This output was obtained in spite of the shops being closed from March 8 to April 11 and December 24 to the end of the year inclusive; also in spite of short time, the men working eight hours a day. Six new locomotives are now under construction. Heavy repairs are made to 57 steel cars per week in a car shed recently built for the purpose. In addition to this work the Philadelphia & Reading operates its own foundry, making all kinds of gray iron castings, including cylinder castings. The railroad is particularly fortunate in the operation of this foundry which is located near the mines and produces good quality castings at low cost. The ordinary manufacturer's selling cost and profit are of course eliminated and there is the other great advantage of getting prompt delivery of castings as needed.

The shop buildings, completed in 1906, are of substantial brick construction, as indicated in the leading illustration showing (from left to right) the boiler shop, blacksmith shop and foundry, with the roof of the erecting shop and two smokestacks from the powerhouse in the background.

From the ground plan, illustrated in Fig. 1, the location of the various departments and their relation to each other will be evident. The main offices are at the junction of Sixth and Perry streets, Reading, Pa.

It will be noticed that the machine, erecting and boiler shops are practically in one continuous building, the boiler shop and blacksmith shop being connected at one end by the storehouse. Only a short space separates the blacksmith and erecting shops. All departments are thus brought relatively close together and this tends to conserve both time and labor in transporting material between the various departments. The erecting shop is laid out in two sections, east and west, with a total of 64 transverse working pits with several additional pits devoted to electric welding and other work. The erecting shops are provided with ample crane capacity to handle the heaviest locomotives, with the exception of the Mallets which are unwheeled on a Whiting hoist in the north machine shop.

The work of repairing steel freight cars has been greatly facilitated by the new steel car shed, one end of which is shown in Fig. 2. This shed is not equipped with cranes and machinery, except electric rivet heaters, welding apparatus and pneumatic tools, but its location within a short distance of the locomotive boiler shop is favorable. The boiler shop is equipped with a large amount of sheet metal working machinery, including a 500-ton hydraulic press which greatly facilitates the manufacture of parts for car repair work.

A feature worthy of special attention is the stock shed

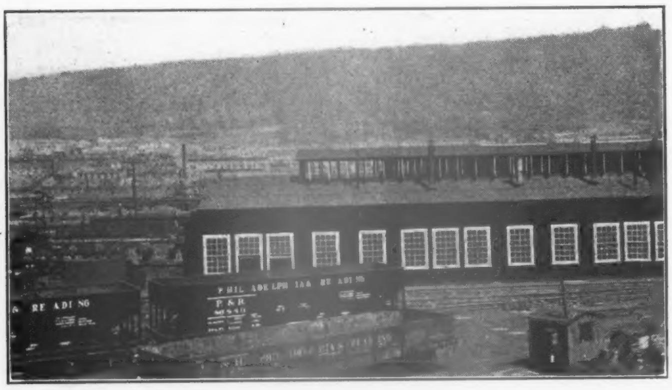


Fig. 2—Partial View of New Steel Car Repair Shed

(Fig. 3), the location of which is shown in Fig. 1. This shed is 548 ft. long by 67 ft. wide, being made with a substantial roof but no side walls. Two 10-ton traveling cranes are provided to handle the material which is carefully stored and protected from the weather. It is difficult to estimate the annual loss from the deterioration of material stored out of doors and other roads could profitably follow the example of the Philadelphia & Reading in providing a substantial, covered stock shed with suitable crane facilities. Owing to the length of time required to make cylinder castings, for example, one or two of each type must be made up in advance and it is an important advantage to be able to store these and other locomotive parts where they will be protected from the weather and can be obtained readily as needed. The north end of the stock shed, shown in the background of Fig. 3, is provided with two lye vats large enough to take driving wheels when necessary and it is here that locomotive parts are cleaned of grease and dirt. One of the stock shed cranes is available for lifting heavy parts in and out of the vats.

The Reading shops are now operating with about 85 per cent of their normal force. Two hundred and nine men are employed in the steel car shed, 127 men in the foundry, 77 men in the electrical repair department and 30 men on outside construction work. The men employed in what may be called strictly locomotive departments are shown in the following list:

Locomotive shop Department	Number of Men Employed
Machine shop	596
Erecting shop	318 (four gangs)
Wheel shop	60
Boiler shop	278
Tank shop	103
Flue shop	42
Blacksmith shop	128
Forge shop	39
Sheet iron shop	110
Powerhouse	42
Laborers	159
Total	1,875

As stated, this force is about 85 per cent of normal. The men are working eight hours a day, five days a week, 200

Fig. 3—A Valuable Asset—The Large and Orderly Stock Shed

men being employed nights, watching, wheeling and unwheeling engines, and for emergency work.

Machine Shop Work

Approximately 20 per cent of the present machine shop force is devoted to manufactured material and outside repair work. There are so many interesting and instructive features

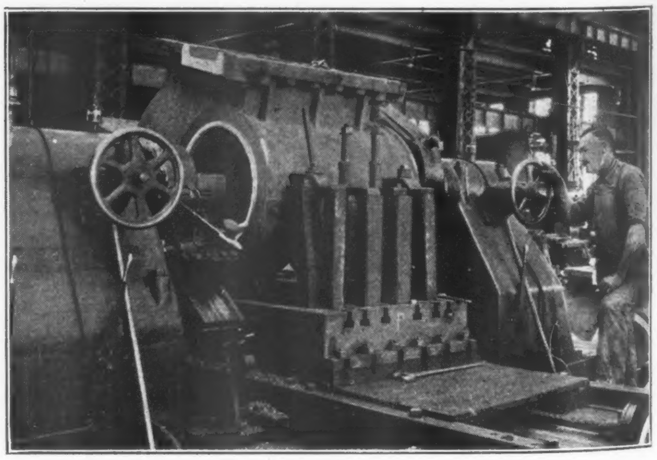


Fig. 4—Powerful Sellers Cylinder Boring and Facing Machine

about this work, as handled at Reading, that space is not available to describe them, except in the case of a few of the more prominent ones. The work on two new Sellers machines, including a cylinder boring machine installed in July, 1921, and a car wheel lathe installed in January, 1922, is worthy of special notice on account of the production secured. The cylinder boring machine, a partial view of which is shown in Fig. 4, is a powerful machine designed to bore and face cylinders and valve chambers, using heavy cut-

ting feeds and speeds. Owing to the proportions and rigidity of the machine, the work is very accurate and the arrangement of operating levers and hand wheels is such as to render the machine easily controlled. Six feeds, varying from .0531 to .7498 in. per revolution of the boring bar, are available on this boring machine, the speed of the boring bar varying from 2.4 to 9.6 r.p.m. The cylinder, shown in

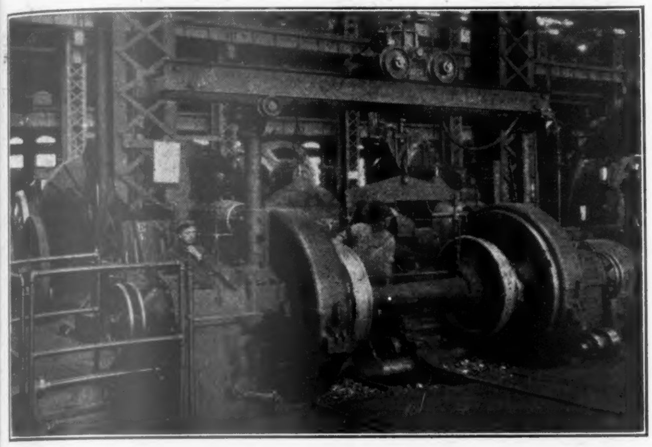


Fig. 5—High Production Car Wheel Lathe Recently Installed

the illustration, has a diameter of 23 in. and is rough bored using a feed of ⅛ in., the finish feed being practically ¼ in. The time required for the operation depends on the hardness of the casting and the amount of stock to be removed.

The method of clamping the cylinder in the machine may have suggestive value, the arrangement being quite plainly shown in the illustration. The cylinder itself rests on a suitable cast-iron bracket bolted to the massive table provided with cross travel. The cylinder is set in this bracket with the saddle resting on the table on the other side of the machine, clamping bolts and brackets being applied as in-

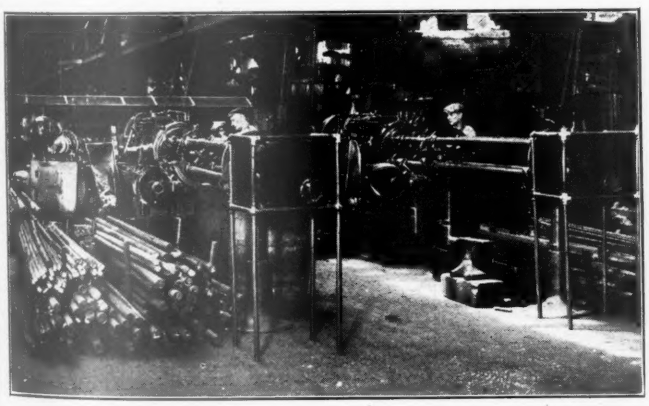


Fig. 6—Gridley Automatics Used for Making Small Parts in Quantity from Bar Stock

dicated. In view of the cutting feeds used, the cylinder must be securely held in place. Since the Philadelphia & Reading casts its own cylinders and it takes considerable time to make a mold and casting, it is necessary to have several cylinders of each class made up and machined in advance. The new cylinder boring machine is, therefore, kept busy on cylinders a large proportion of the time.

Highly satisfactory results are being obtained with the new car wheel lathe, shown in Fig. 5. This car wheel lathe can be operated with ⅛-in., ¼-in. or ⅜-in. feed, the speed of the face plate varying from 1.1 to 2.2 r.p.m. The ⅜-in. feed is usually employed with a cutting speed of 30 ft. per min., the maximum depth of cut being about ½ in. The convenient arrangement of tracks and pneumatic hoist for applying and removing wheels is evident from the illustration and the entire design of the machine has been developed with one thought in view; namely, to turn car, engine truck and tender wheels in the shortest possible time and with the least effort on the part of the operator. The machine has fully four times the productive capacity of car wheel lathes made 15 or possibly 10 years ago.

A considerable proportion of the manufacturing work at Reading shops is done on a battery of four Gridley automatics, three of which are shown together with storage racks for the bar stock in Fig. 6. These machines are made by the Windsor Machine Company, Windsor, Vt., and include two 4-spindle machines with a capacity to take work up to 2½ in. in diameter by 7 in. long and two 1-spindle machines with a capacity to take work up to 3¼ and 4¼ in. in diameter respectively. Fig. 7 shows a few typical ex-

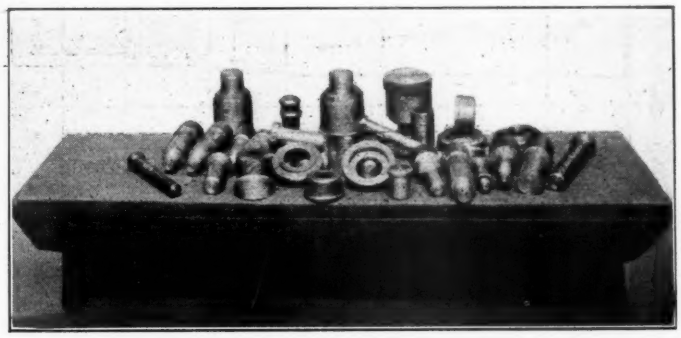


Fig. 7—Typical Examples of Work Done on the Automatics

amples of the work done on these automatics including the work mentioned in the following list:

PARTS MADE ON AUTOMATICS

Spring rigging pins up to 7 in.	Blower valve sleeves.
Rivet set blanks	Standard studs.
Slip rings for driving box brasses.	Set screws.
Knuckle pins.	Balance plate studs.
Standard switch bolts.	Wedge bolts.
Eccentric rod pins.	Boiler plate switches.
Spring rigging bushings.	Boiler plate punch dies.
Front-end main rod key washers.	Grease cup sockets.

The way in which three of these parts are machined will be described in detail as typical of the work performed on the automatics. A close-up view of the 4¼-in., 1-spindle

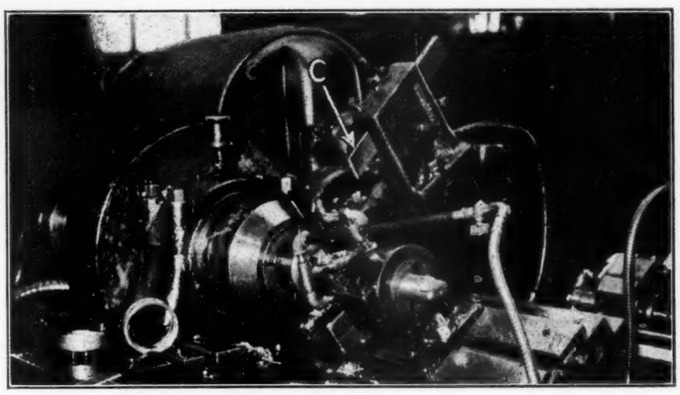


Fig. 8—Close-up View of Automatic Making Slip Rings

machine is given in Fig. 8, the particular operation involved being machining slip rings for driving box brasses. These rings are made from bar stock, the operation of turning the outside diameter and boring the large hole in the center being performed at one time by the drill and turning tool in one position of the revolving tool head. In the second tool head position the inner edge of the slip ring is beveled. In the final operation, cutting tool *C*, held in a heavy pivoted arm, swings down and cuts off the ring. An ample supply of cutting oil is provided to lubricate the cutting edges of the tools and

carry away the heat generated, enabling these slip rings to be manufactured in quantity and in far less time than would be required by other methods.

This battery of automatics is well adapted, naturally, to the quantity manufacture of all sorts of pins, a representative eccentric rod pin being shown in Fig. 9. This pin is made on one of the four spindle machines, the operations performed in each position being as follows: First position—turn body size to $1\frac{1}{2}$ in. and body thread size to $1\frac{1}{4}$ in.; Second position—counterbore in rear of thread, turn 1-in. end;

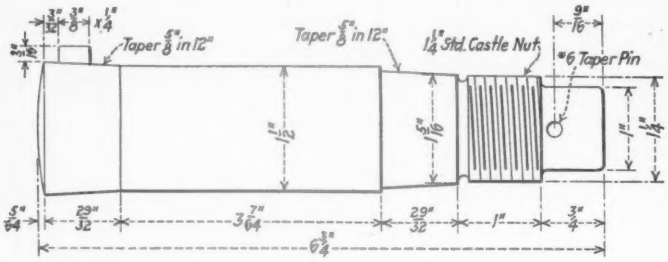


Fig. 9—Drawing of Representative Eccentric Rod Pin

Third position—form tapers, thread; Fourth position—cut off. To make a complete change of the machine and set-up requires about three hours so it obviously would not pay to set up this machine for three or four pins. There is a certain limited number for which it is economical to set up the automatic and all pins made in excess of that number represent a continually decreasing cost per piece.

Front-end main rod key washers, a typical example being shown in Fig. 10, are made on a 1-spindle machine. The revolving tool head has four positions on which tools are assembled to perform the operations of machining these washers in the following sequence: First position—drill washer and form outside diameter; Second position—counterbore; Third position—form tapers, cut off; Fourth position—not used. In this case also it takes about three hours to set up or tool the machine, consequently the runs are made as long as possible.

In addition to turning out the work on this battery of

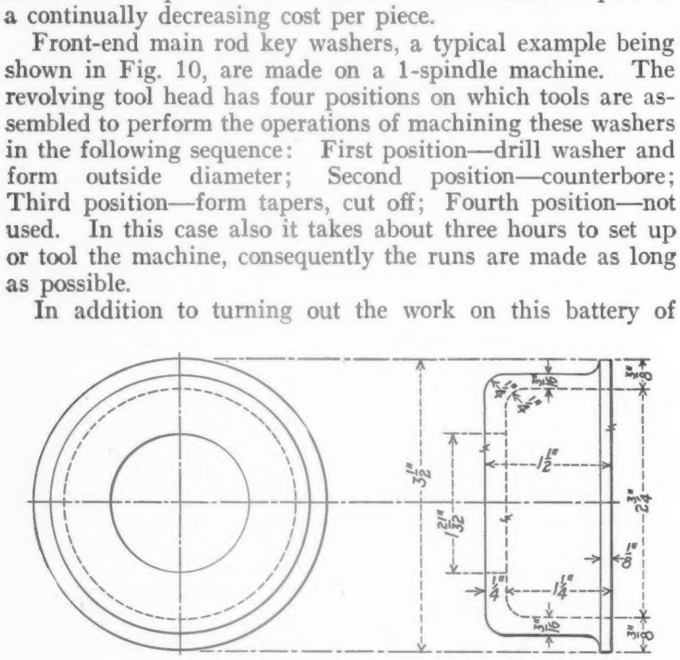


Fig. 10—Front End Main Rod Key Washer

automatics more rapidly than would be the case on engine lathes or even turret lathes, the labor cost is greatly reduced because one operator can take care of two machines. After insertion of the bar stock the machines are fully automatic in action and require no further attention except in a general way to see that they are properly lubricated and that the cutting tools are kept in good condition. In certain instances, however, the operator is able to speed up the indexing by hand operation.

Drop Forging and Spring Shop Work

Two features of especial prominence in the blacksmith shop are the work done under drop hammers and the comparatively new spring shop equipment for repairing and rebuilding springs. The drop hammer work is centralized at one point where there are two steam drop hammers of 1,500 and 1,000 lb. capacity respectively, together with two E. W. Bliss trimming presses for removing the flash. One drop hammer and trimming press making large hexagonal nuts are shown in Fig. 11, the dies and method of forming the nut being shown in Fig. 12.

These nuts are made in sizes from $2\frac{1}{4}$ to 3 in. The 3-in.

Fig. 11—Drop Hammer and Trimming Press Making Large Nuts

nuts, illustrated, are made from cylindrical blanks of $3\frac{3}{4}$ in. round soft steel stock cut up in pieces $3\frac{3}{8}$ in. long. The blanks are heated in the furnace, shown in the rear of Fig. 11, the drop hammer at the right having been equipped with the two forming dies. When sufficiently hot, one of the blanks is placed in the bottom die and two or three strokes of the hammer give the nut its hexagonal shape, forming the

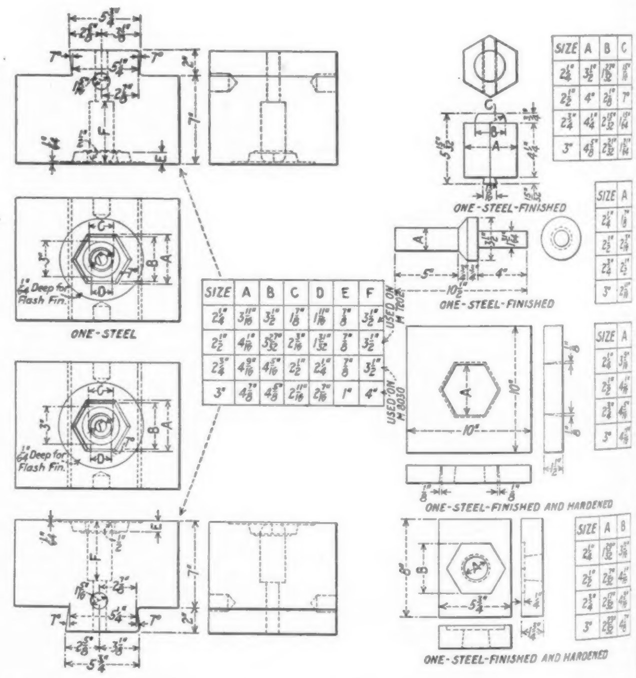


Fig. 12—Forming and Trimming Dies for Making Hexagon Nuts

hole with the exception of a flash at the center. There is also a flash around the sides of the nut. The external flash is removed by hexagonal trimming dies in the press, shown at the left of Fig. 11, the center hole in the nut being cleared out by means of cylindrical punch and die A, operated by eccentric E.

The arrangement of the dies for both forming and trimming the nut will be readily apparent from an examination of Fig. 12 which shows the dimensions of these dies for four

different sizes of nuts. One man operates both the drop hammer and trimming machine. In addition to securing a high production and relatively low labor cost for nuts manufactured in this way, the action of forming them under a

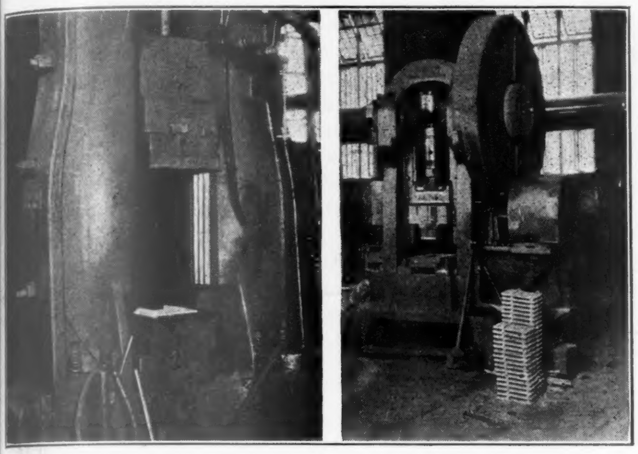


Fig. 13—Drop Hammer and Trimming Press Making Column Guides

drop hammer improves the quality of the nuts and makes them less liable to fail.

A typical job on the other drop hammer and trimming press is illustrated in Fig. 13 which shows the process of manufacturing column guides for freight car truck bolsters. These guides are made from blank stock 1¼ in. by 4 in. by 10¾ in. The stock is heated in a second furnace adjacent to the drop hammer; when brought to a white heat it is placed under the drop hammer shown in the left of the illustration. Two, or at most three blows of the hammer are sufficient to form the column guide, but leaving a slight flash as in the case of the nut. This flash is removed under the trimming press shown at the right in Fig. 13. The column guide is then usually placed back under the drop hammer for one or more strokes to make sure that it is accurately formed in accordance with the die and smoothly finished. Two piles of finished column guides are shown on the floor at the right of the trimming press in Fig. 13. Fig. 14 is a drawing of the column guide as forged and drilled. As in the case of the nuts, one man handles this work on both the drop hammer and press. Experience has demonstrated that this is a cheaper method of obtaining high quality guides than to buy them.

In addition to the two jobs mentioned, these drop hammers

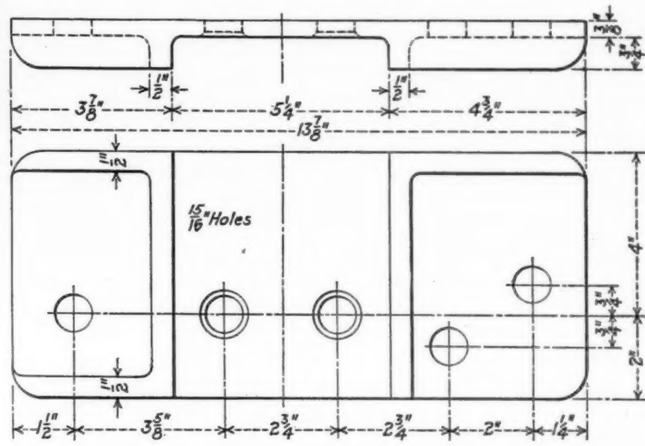


Fig. 14—Column Guide for Freight Car Truck Bolster

are used for the manufacture of various parts of locomotive motion work, including guide blocks, eccentric rod jaws, cylinder cock jaws, steam hose clamps, both plain and castellated nuts, and many other parts. For the more common parts, dies have already been made and saved many times their cost.

(To be continued)

Methods of Training Railway Shop Foremen

A Discussion of the Need for Foreman and Group Leader Training; Outline of a Typical Training Course

By Hugo Diemer

How can the latent capacities of the railway shop foreman be most effectively developed so as to make him realize and exert to the fullest his part in bringing about greater efficiency?

In my experience as a shop superintendent and industrial engineer, I have had occasion to observe the type of mechanic and foreman who has come into other industries from the railway shop. The outstanding characteristics of the railway shop man when he comes into a manufacturing shop are:

1. A very praiseworthy quality of resourcefulness. He has been accustomed to get results with poor equipment and poor tools. He has been schooled in the importance of getting work done the best way possible with poor facilities. The outstanding fact, however, is that he does manage to get the work done somehow. If he happens to get into the maintenance and repair department this quality is a very desirable one.

2. This willingness to be satisfied with makeshifts is, however, quite harmful in work where interchangeability and economy of production are essential. Neither railway mechanics nor railway shop foremen taken as a whole, have been given systematic training in either modern mechanical methods or modern methods of organizing production work. Is not this really the reason why many railroad shops find it cheaper to farm out a great deal of their work to shops where modern methods have become thoroughly established? I have had occasion as head of engineering and shop work in two large educational institutions to be located very near to, and to be closely associated with the shop work of a prominent western railroad for three years, and with the shop work of a prominent eastern railroad for eleven years. In the case of the western railroad shop I have seen the installation of improved stores methods, better equipment and a more satisfactory wage system which, while it constituted a great step forward, did not by any means put the railway shop on a basis of real equality with a modern commercial industrial shop. In the case of the eastern railroad which about ten years later adopted these methods, I saw the same improvement. It was, however, a slow process of conversion of even the engineering and higher executive staff that brought about these changes. This staff were, by reason of the fine reputation of the road as a whole, inclined to discount the idea that they could learn anything from other industries. Having now made the improvements in the way

of centralizing stores, better equipment and more scientific piece rates they are still inclined to be skeptical as to the applicability of the organization and training methods of the modern industrial shop to the railroad field.

In the railroad shop as in the industrial shop the foreman is the connecting link between the management and the worker—the key man, the top sergeant who reports the policies and orders from the front office and passes them on to workers under his direction. It is his job to convert plans into product. To do this he must know how to handle men; he must understand company policies; he must be able to pass them on to his workers in a manner that they will understand; in other words, he must be a leader, an executive. Nobody can attain leadership without paying the price for it, which means he must be willing to study. The present day foreman cannot employ the old "driving" tactics and hope for much success in his efforts.

Too often the foreman promoted from the ranks has become overbearing and arrogant in his treatment of those now under him. If the foreman is cheerful, loyal and efficient, the men under him naturally tend to become that way also; while the foreman who is unfair, a tyrant, or a toady, will do more damage to an organization in a day than his influence on production can undo in a year.

The foreman of today is a human engineer and must be able to gain confidence and good will. As such he must prepare himself for industry's big job, the education of the worker. Education must therefore begin with the foreman, for from him it will naturally reach the worker.

The outstanding need in industry today is for foremen who not only know what is to be done and how to do it, but who also know how to convey that knowledge quickly and surely to the workers directly responsible for doing a job. Training departments, no matter how well developed, can never take the training entirely out of the hands of the foreman on the job. Getting successful results in training employees involves not only methods of quickly acquiring manipulative skill but also standardizing intelligent leadership.

Development of Foremanship Training

Foremanship training is a term which has come to be applied to those agencies which attempt to prepare individuals for discharging effectively the responsibilities of the foreman's job. It further is used to familiarize others whose work draws them in contact with foremen and foremanship problems with the underlying principles and practices of foremanship.

As the idea of foremanship training has grown, it has come to be generally recognized that a survey of the people who can profitably make a study of foremanship includes a wider range than just practicing foremen. It is desirable to include in this training men filling minor executive positions such as gang leaders, sub-foremen, assistant foremen; also others such as storekeepers, tool department heads, cost clerks, inspectors, who come in contact with foremanship problems.

Few foremen have ever carefully analyzed their own methods of handling men and work. The foreman is not to be blamed for this failure to analyze his situation, for it is but the result of the schooling which industry has given him ever since he began as a workman. There is something about the atmosphere of the average shop with its commands and orders, its "do as I tell you" and "ask no questions" which dulls the finer sensibilities of both foreman and worker. It is only natural that a foreman should acquire a dual personality; on the one hand a personality of good fellowship, which reveals itself to his family and relatives, and on the other hand the petty tyrant of the shop. The foreman does not want to assume a mask in the shop, but he does it because he thinks that is the way the management wants him to act. Under the pressure of his position he acts hastily, tactlessly and at times blunderingly.

Much of the apparent loyalty of the foreman to the management is only assumed and is part of the occupational mask mentioned before. In foremanship classes, where some representative of the management sits in with the foremen, it has been found that in answer to the question, or in the point of view taken in the discussion, the foremen talk only as they think the management would like to hear them talk. Only too often the management gets from the foreman that which the foreman thinks the management would like to have.

In reality, loyalty is measured in the way the foreman feels at heart toward the management. If America has been able to succeed so well industrially in the last few years with discontent and disloyalty so prevalent, what could she not do if the foreman and the workers had their hearts in their jobs? After all, the biggest result to be gotten out of any plan of foremanship training is this co-operative spirit founded on a clear understanding of the real basic facts connected with the foreman's job.

Four Common Methods of Training Foremen

The methods of foremanship training and the content matter of training courses are so intimately interwoven that it is best to consider them together. There are four prevalent methods of such training:

In the first, or disconnected lecture method, it is customary to get department heads to give prepared talks to foremen on such subjects as Purchasing, Storekeeping, Cost Accounting, Maintenance, Problems, Planning, Scheduling, Employment, etc. In this method we can expect increased general intelligence with regard to the problems of the organization as a whole. If some lectures of an inspirational type are introduced they may produce an inspirational effect provided the men are able to follow the lecturer and thoroughly grasp the points set forth.

The second plan, namely of co-ordinated lectures, is usually the outgrowth of a year's experimenting with the first plan. The department heads' talks are edited and put into educational form and all the talks are arranged in some kind of rational sequence. In this method we also often have a specific objective. For example, better co-operation between foremen and their superiors, or the improvement of the foreman's attitude in dealing with his men. This method may be expected to promote general improvements in the field covered by the lectures, if the lecturers know how to create and maintain interest and have an aptitude for imparting information clearly.

In the third, or conference method, the responsibility for results is centered in the group leader. He has a sequential program as in the second plan but instead of having the foremen listen to a talk they get only a few remarks by the leader accompanied by perhaps a chart or two. He asks questions which have been carefully prepared with a view to tying up the work of the man who is asked the question with the subject under consideration. The object is to stimulate the members of the group to think and form opinions and judgments of their own.

The members of the group are active, not passive or merely listeners. The conference leader in this plan must establish personal relations with members of the group and vary his method according to the particular make-up of different group members. The conference plan can be used to give training by means of the case method under it. Pooling of experiences is made possible. The number of individuals competent to conduct conferences without special training is of course limited.

The problems and questions must be prepared in advance. In order that the foreman can solve these problems we must first of all develop in him what we may call an industrial intelligence. The development of industrial intelligence involves a discussion under the leadership of men familiar with the actual conditions under which the foreman operates. The program of discussion should be built around men,

materials, equipment and systems as they exist in the particular work of each member.

In the fourth plan the conferences are supplemented by systematic home study. There is a consensus of opinion among the best authorities that a definite co-ordinated content matter in the way of reading and problems to be studied at home by each group member, greatly strengthens the conference plan. Best results are obtained when this content matter is brought home to the foreman in such a way as to develop his thinking and initiative in applying the ideas to his own work and problems.

At present there is a wealth of material available to form a basis for the content matter of a course in foremanship training. Standardized courses in detail have been prepared with the co-operation of the best educational, industrial and editorial talent in the country. The adaptation of this standardized material to the peculiar needs and conditions of any business is far more easily accomplished and much more economical than to attempt to prepare special home-made courses.

In the conference plan with home study, it is particularly important that the man who conducts the conferences have the unqualified co-operation of a chairman of the group. This chairman is preferably a man whose position outranks that of the other members. In order to get the best work from the group the chairman must conscientiously do all the required home study and work out the problems himself. It is his example and leadership that will result in 100 per cent work by the other members.

Outline of Typical Training Course

As a typical example of the content matter of a foremanship training course the following outline of a course which I have helped to create will be representative. The arrangement and sequence in this course have been given careful thought and co-operation by an advisory counsel composed of industrial managers, production managers, personnel managers, educators and foremen.

Fundamentally the instructional material is based on the application of the methods of job analysis to the foreman and his job in the plant. In making this job analysis questions were handed to over 5,000 foremen in various industrial plants so as to get the foreman's own expressions and ideas as to what a foreman has to do and what kind of a man he ought to be. With this idea of job analysis as a basic one running all through the course, the material is divided into four groups.

The first group deals with the human element in industry and the foreman's responsibility for molding all sorts and conditions of men into a unified working force. The competent foreman must grasp his opportunity to build the team spirit. Before he can do this he must learn the qualities, characteristics, intimate desires and motives of men, how men think and feel and act; the foreman must know how to use this knowledge of human qualities to attain to leadership himself. He must learn how to develop the essential personal qualities for team leadership. This first group also deals with the subject of training a working force, discussing fundamental principles and methods of teaching and training in the shop.

The second group deals with job analysis with illustrations by cases and problems. The flow of work through a plant, the principles behind all planning and production methods, the effect of shop conditions in getting out the work, and the qualities of a good production man are discussed in this group.

The third group deals with the foreman as a business man. It discusses his participation and co-operation in stock keeping activities in keeping down production costs and material wastes. It presents the purposes and typical records of central stores and efficient practice in stock handling, not only in the stockroom but everywhere in the shop. The fundamentals of cost keeping are taken up, the stress being on practice rather than systems. The topics discussed are not of an accounting nature but include such matters as productive and non-productive labor, material and expense, depreciation, predetermined costs and cost control.

The fourth group discusses foremanship in its relation to economic and social matters. The economic facts and factors on which production and industry are based, the knowledge which it is necessary for any men to possess who would think straight on industrial questions and shop problems. Certain aspects of the law are taken up, with which the foreman should be familiar. Those activities of industrial service which are usually carried on by the personnel department, when there is such a department, but in which the foreman must be a participating factor, are taken up in this group.

Group Leaders Must Be Trained

The recognition of the benefits to be obtained from the group training of foremen has resulted in the development of courses of instruction for men desiring to become group leaders. We have recent bulletins of the Federal Board for Vocational Education and of the various state departments devoted to the subject of instructor training in foremanship work. Personally conducted classes for the training of instructors and group leaders in foremanship have been organized and carried on as resident courses by state and private educational institutions and as extension work of various state institutions.

Examples of what is contained in these teacher training or group leader training courses are as follows:

Unit 1—The analysis and classification of what is to be taught.
Unit 2—Thinking it over; what instruction is; how to get the best results out of discussion; developing broader intelligence.
Unit 3—Lesson planning; tying up auxiliary information with a standard lesson.
Unit 4—Difficulties in learning; getting local production problems into an effective instruction sequence.
Unit 5—Handling a group for effective instruction. Interest and interest factors; instructional conditions as affected by surroundings and materials.

The above is the merest abstract of what is the general content of intensive teacher or group training courses. But it will serve to show how generally we are coming to recognize the important position of the group leader in foremanship training. We must recognize also that in this field as in the teaching field in general a person may have the sincerest desire to be a good group leader, and may take the best of training and still fail. The earnest hard worker who lacks personality and vitality will not fill the bill. Neither will the smart fellow with lots of assurances and affrontery but without a background of real hard work. The most successful group leader is apt to be a man who has had actual industrial experience either by necessity or by choice and who has advanced to a higher position. A man of good physique with pronounced personality and who has sufficient humility to study hard the fundamentals applicable to all foremanship training as well as the peculiar problems of his own situation comes nearest to filling the requirements.

According to the last published census of manufactures, 98 per cent of all American industrial plants employ less than 250 people; there are 3,000 plants employing 250 to 500 people; 1,400 plants employ from 500 to 1,000; and only 648 plants employ over 1,000 people. The big industries in general have come to recognize pretty well the advantages of foremanship training.

Foreman Training Important as Scientific Management

It is the realization of the tremendous field of possibilities in the smaller industries that justifies the growth of the movement for foremanship training. We are only at the threshold of this movement. Those who are active in the movement and who have had an opportunity to observe and measure its results feel confident that ultimately it will prove as important as scientific management in bringing about greater industrial efficiency and in maintaining America's industrial supremacy.

Principles of Oxyacetylene Fusion Welding
Part 4—Welding Cast Iron, Continued

By Alfred S. Kinsey*

IN the preceding article some of the early steps to be followed in making welds in cast iron were explained. The following paragraphs deal with the methods of doing the welding and the necessary procedure in finishing the work.

9. *Cast Iron Welding Rod Should Be Carefully Applied.*—In the use of welding rod to fill the vee of a weld two things are essential:

(a) The rod should be of the proper chemical and physical composition. Cast iron contains carbon, silicon, manganese, phosphorus and sulphur. The amount of silicon is about 2.50 per cent. This element is very sensitive to the heat and easily burns out when the metal is melted to make a weld. That is, if a piece of cold cast iron is heated to the melting temperature it will lose about 0.25 per cent of its silicon. The silicon in cast iron combines with the carbon and thereby causes the iron to be hard or soft depending on the amount of silicon. If an iron casting therefore should contain 2.50 per cent silicon and welding should reduce this 0.25 per cent the metal would be much harder at the weld. Then if after the weld is started the welder is interrupted so that the molten metal becomes cold he will have to remelt it to proceed, and this may happen three or four times during a weld, thus reducing the silicon to say 1.75 per cent. This amount of silicon causes the combined or hardening carbon to influence the metal more than the graphitic or softening carbon, and the weld will be so hard it cannot be filed or machined. This often accounts for the brittle cast iron welds which sometimes puzzle even a good welder. Now to prevent this desiliconizing of a cast iron weld the welding rod is made to contain about 3.00 per cent or 3.25 per cent of silicon, which allows for the usual loss of this element and leaves the filled in metal with about the 2.50 per cent of silicon required to keep it machinable. Therefore the composition of cast iron welding rod is of first importance. Just scrap iron or rod of uncertain composition will not do.

Fig. 1—Bar Shears Reclaimed by Welding. The Head Was Broken Off and Machine Scrapped. Saving by Welding $2,000

(b) The rod should be properly fused in the vee. To make a strong weld the rod must be properly fused to the sides of the vee. This can best be done by a continuous flow of metal from the end of the welding rod. Some poorly trained welders have been known to melt off a cold piece of the rod an inch or two long, drop it down in the vee and then whirl the torch flame over it to melt it quickly. The dropped end rarely ever is completely melted, and does not make good fusion, and the practice should be condemned as being unsafe. To obtain a rapid flow of metal to fill a big vee the best way is to bunch two or three rods and melt their ends all at once.

Considering that none of the chemical and physical characteristics of the metal needs to be lost in a cast iron weld made with the oxyacetylene torch, it would seem unfortunate to sacrifice these possibilities by the use of an improper welding rod or by the careless application of a good rod.

10. *Cast Iron Cannot Be Welded Without Using a Flux.*—When cast iron is being melted by the oxyacetylene torch it will be noticed that a film of molten sluggish material covers the pool of metal and prevents it from being brought to the proper melting temperature. This coating is composed of iron oxides and dirt, whch are released from the metal as it melts, and float to the surface because they are lighter than the pure iron. The iron oxides and dirt form a liquid slag having a melting temperature higher than that of the molten iron under it. It is almost impossible to melt the pure iron through this slag. Therefore a flux is thrown upon the molten oxides, with which it unites, forming a compound having a melting temperature lower than that of the cast iron. Then it is easily possible to melt the oxides out of the way and complete the weld with the clean metal. Cast iron fluxes are usually made from potassium chlorate, borax, caustic potash, salt, etc. The flux is usually applied by heating the rod, dipping it down into the can of flux and then melting the rod and the flux sticking to the rod simultaneously into the vee of the weld.

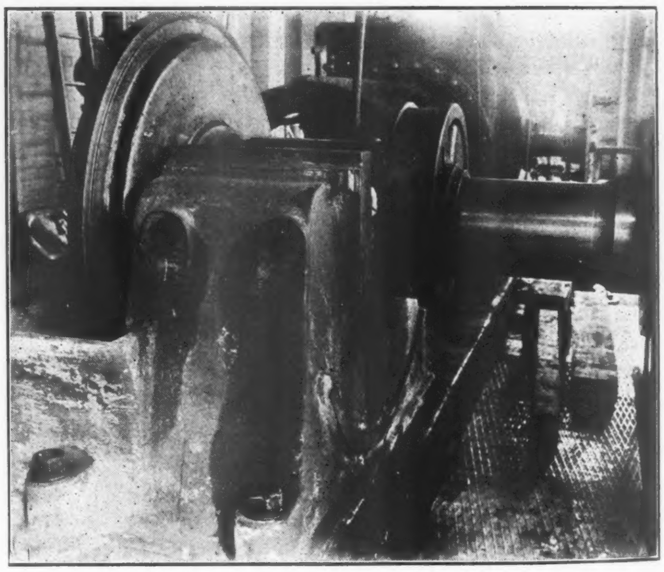


Fig. 2—Welded 7-Ton Air Compressor Casting

Flux should be used with moderation. If it is applied too freely there will be a tendency to make the weld porous, and in the finishing of a weld too much flux will probably form

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a hard scale on the surface. If this should accidentally occur the scale can be removed by rubbing an old file over it while it is still dark red hot. But of course it would be better to use the flux more sparingly.

11. *Cast Iron Welds Should Be Carefully Reinforced.*—By the reinforcement of a weld is meant the amount of weld metal added to the vee after it is full. It usually is thought that the greater the amount of metal added to a weld, thereby increasing its thickness, the stronger would be the weld. This is not always true under the following conditions:

(a) If the welder in beveling should leave sharp corners at the top of the vee, a strain on the weld is liable to break it at the corners through to the surface of the reinforced material. This is due to the cleavage planes formed by the poor arrangement of the crystals at the sharp corners. Designers of machinery always fillet the corners of metal parts receiving heavy strains for this very reason. The corners at the top of the vee should be melted down and rounded with the welding torch before the reinforcement is added.

Fig. 3—Welding Defective Condenser Casting

(b) If the reinforcement is only on one side, the center line of the pull on the base material is not the same as the center of pull of the weld. This would make an eccentric load or strain on a weld which might cause it to rupture. For example, suppose a bar one inch thick is single-vee welded and reinforced only on one side, the reinforcement being say 1/4 in. thicker than the bar. Then the center line lengthwise (longitudinally) through the weld would be 1/8 in. higher than that through the bar, which would cause an eccentric or bending strain through the weld while there would be a straight pull or tensile strain through the bar. This would be liable to break the weld open, as one might bend and break a stick over the knee. This eccentric load would be eliminated by reinforcing a weld on both sides, which suggests this rule of practice: *Whenever practicable double vee and reinforce a weld on both sides.*

12. *Cast Iron Welds Should Be Reheated.*—Unless a special furnace is used for the preheating of a casting it probably will gradually lose its heat and require to be heated up again, and this may happen a number of times during the making of a weld. Under such conditions strains are set up in the grain structure which are greater in some than in other parts of the metal. These unequal granular strains make themselves known sometimes without warning and when there is no load on the casting. Other times they cause the failure of a casting when it is under heavy strain. Sometimes a moderate hammer blow on or near the weld will cause the locked up stresses to be released, thereby developing a surface crack.

All of this trouble may be overcome and the unequal strains in a casting relieved by reheating. That is, after the welding is completed the casting should again be heated, covered thoroughly and allowed to cool slowly until quite cold before exposing it to the air.

13. *Cast Iron Will Expand on Heating and Contract When Cooled.*—If a piece of cast iron is heated from the cold to the molten condition it will be expanded to its limit. Then as it cools to the original cold state it will contract almost but not quite to its first dimensions. This movement of the granular structure of the metal will be about the same in all directions providing the metal is of uniform thickness and width. Many castings, however, are constructed of thick and thin parts, like an ordinary pulley, for example. Then there will be unequal expansion and contraction throughout the casting, and special precautions must be taken to allow for these changes of dimension. For a plain straight casting in which the expansion and contraction is uniform and unconfined, no special preparation need be made for its heating by the oxyacetylene torch. But for castings of intricate design preheating will be necessary. Let us see how this would take care of the expansion and contraction of cast iron.

Expansion.—A metal like cast iron consists of crystals, grains and the chemical elements common to all irons and steels, i.e., carbon silicon, manganese, phosphorus and sulphur. Each flat sided grain is composed of a group of crystals which are uniformly interlocked. The grains are held together by the law of attraction. Now when heat is applied to a piece of cast iron the crystals respond by gradually separating. This enlarges the grain they form and at the same time the power of attraction or cohesion is reduced from say 30,000 lb. per square inch in the cold state to nearly zero when the iron is in the liquid condition. The growth of the crystals and the corresponding enlargement of the grains increases the size of the piece of cast iron. This is expansion. Naturally the thicker the piece of metal the greater the mass of crystals and grains and the greater the amount of heat necessary to produce the expansion. Therefore if an iron casting is composed of thick and thin parts, the thin portions will be the first to receive the effects of the heat and will expand before the thicker, slower sections. This unequal rate of expansion sometimes will start small

Fig. 4—Welded Cast Iron Superheater Header

cracks in the metal. The expansion may be made more uniform, however, by using an abundant supply of heat, say from a big oven or an oil torch.

Contraction.—Just as the crystals and grains of iron were allowed to separate by the heat weakening the cohesion holding them together so the withdrawal of the heat from the metal and the fall of temperature allows the law of cohesion to operate again thus pulling the crystals back in place, reducing the size of the grains and contracting the whole piece of metal as it cools and becomes solid. This is contraction. Now it readily will be seen that if an iron casting having thick and thin sections has been heated red hot and expanded to the limit throughout, when the heat is withdrawn from it and it is allowed to cool in the open air of a shop, the thin parts will be the first to lose their heat. Then the casting will be in two thermal conditions, the thick parts hot, with grains weakly held together by low cohesion, and the thin parts cold, with the grains pulled back together by almost the original power of cohesion. Of course there will then be junctions of the hot and cold metal where the power of attraction will be in opposite directions and the pull of the contracting grains of the colder metal frequently will be sufficient to fracture the joint. These usually are called shrinkage cracks and are due to unequal contraction. A simple method for preventing shrinkage cracks is to surround the iron casting with an envelope of heat of sufficient volume to retard the cooling of the thin parts so that they do not get cold before the thick ones. This causes a uniform rate of shrinkage of the grains throughout the whole casting and prevents unequal cohesive pull as the crystals and grains contract. In the oxyacetylene welding of a cast iron locomotive cylinder, for example, uniform expansion and contraction of the metal is accomplished by heating the whole cylinder inside of a fire brick casing built around the job with a space of a few inches between it and the brick covering. Taking one brick out at a time provides the necessary opening to do the welding, and then closing up all openings in the brick jacket after the weld is completed and the preheating stopped envelops the cylinder in an atmosphere of high temperature which cools so slowly that the grains of the thick parts shrink at the same rate as those of the thinner sections.

New York Central Engine Terminal at Syracuse

Interesting and Economical Design With Unusual Ash Pits Characterize Solvay Enginehouse

The New York Central has recently completed and placed in operation an interesting 30-stall enginehouse and terminal layout at Solvay, outside the city limits of Syracuse, N. Y., for the care of passenger locomotives turned at this division point. The new terminal, which replaces one that had become congested and crowded because of its circumscribed limits within the city, contains many features of economical design, construction and operation which are a departure from ordinary practice. This is notable in the design of the ash pits, which are circular in section, of concrete and economical both in cost and operation.

A Compact Well-Arranged Layout

Location and General Features of the Terminal

The new terminal had been under consideration for a number of years preceding the war and in 1918 construction was started but on account of financial and other conditions little was done. Work was resumed in 1921 and the project was carried through rapidly to completion. The layout is primarily for the care of passenger train locomotives received from and sent out over the several divisions of the New York Central centering at Syracuse. Some freight power is handled, however, as well as switching locomotives. The terminal is located about 3.5 miles west of the Syracuse passenger station. It adjoins the four-track main line to Buffalo and the two-track line of the West Shore Railroad, also a part of the New York Central.

The terminal includes a 30-stall enginehouse of brick walls and timber roof on concrete foundations which is served by a 100-ft. turntable. All stalls are completely equipped with modern facilities, including electric welding and are exceptionally well lighted, aside from the natural light, by a comprehensive overhead direct lighting system. Portable inspection lights are also provided. Flood lights are used in considerable number in and around the turntable, the ash pits and the coaling station. A modern power plant furnishes hot air for heating, steam and compressed air. A well equipped machine shop adjoins and is a part of the enginehouse, as are the offices, etc. The coaling plant has a rated capacity of 1,000 tons with duplicate hoisting machinery.

Both the New York Central's four-track main line and

the West Shore's two-track main line pass through Syracuse and there is a heavy through passenger and freight traffic over both of these lines. There is also considerable traffic which originates at or is destined for industries in Syracuse

Arrangement of the Three Ashpits on Inbound Tracks

and the immediate vicinity. In addition the Rochester division, better known as the Auburn Road, leads to the west, the Ontario division to the north and the Chenango branch to the south. The traffic handled through Syracuse is naturally large and the problem of turning power quickly and efficiently becomes important. Under the method of operation now in use in connection with the new terminal, freight and passenger engines are, with a few exceptions, turned at

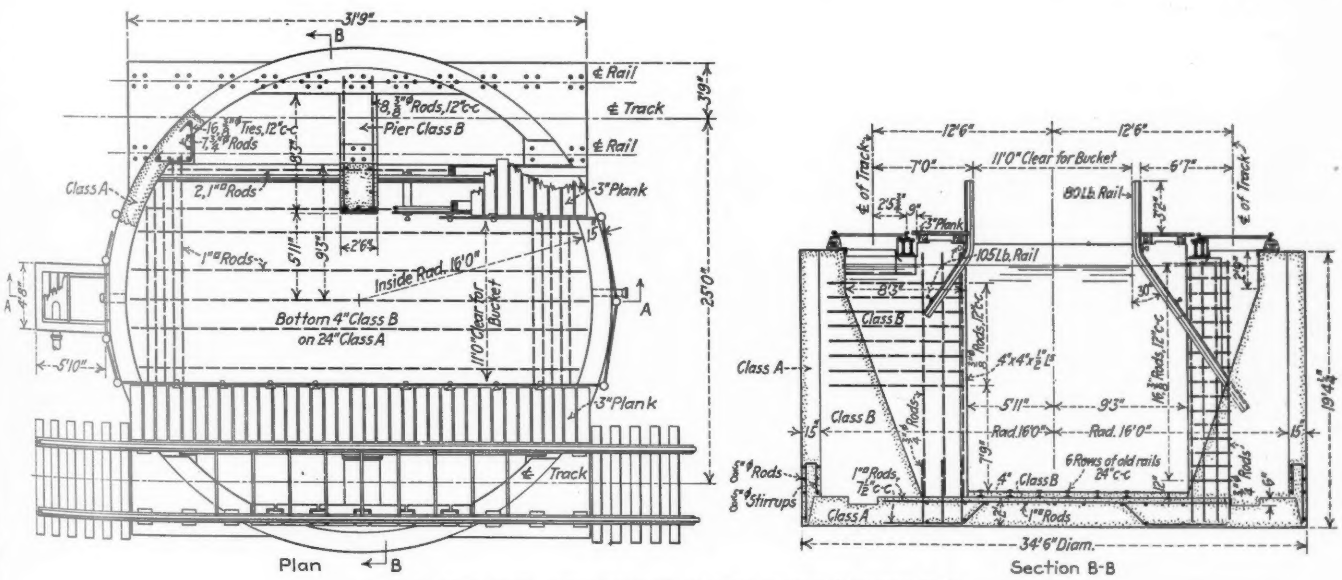
sion is about 30 trains daily each way and the number over the Mohawk, its complementary division, is about the same. There are about six passenger trains each way over the Ontario division, about five each way on the Rochester division and about three each way on the Chenango branch. Added to this number of passenger train movements, there are five double header freight trains each way on the Ontario division while from one to three coal trains are received daily from the Pennsylvania or handled by the Pennsylvania from Elmira, N. Y., over the Central's line. Thus 85 or more locomotives are handled daily without taking into account the switching power housed and handled at Solvay.

The Ash Pits Are of Unusual Design

The ashing facilities at Solvay are easily the outstanding features of the Solvay terminal because of their departure from ordinary practice, their low cost and their ease of construction. The arrangement consists of four wet ash pits of mass and reinforced concrete, built in the form of circular wells. Three of these pits are located under the inbound engine tracks and one under one of the outbound tracks, thus providing ashing facilities for outbound power, an arrangement of which the advantage is obvious.

Certain advantages are accorded to this type of pit which are of importance. They can be built for about $11,000 each, exclusive of water connections and drainage. Three pits, giving the same number of engine positions as would be permitted by a 200 ft. pit, can be built for less than half the first cost of the long pit.

As compared with the long 200-ft. pit, there is very much less structure to maintain. In the case of the long pit, 400 lin. ft. of steel girder construction must be maintained, as contrasted with 150 ft. for the three small pits. The storage is concentrated directly opposite the engine positions for the full capacity of the pit, and until any one pit is completely



A Plan View and Cross Section of One of the Circular Pits

separate points. Freight power from and to the west, i.e., locomotives used on the Syracuse and Rochester divisions, are handled at DeWitt, a combined engine terminal and freight yard, while those on the Mohawk division (Syracuse to Albany) are handled at Minoa. Both of these terminals are east of Syracuse proper. Other freight power is ordinarily handled at Belle Isle to the west but at the present is being turned at Solvay.

In more detail, the power now turned at Solvay consists of both passenger and freight locomotives for the following approximate number of trains and divisions over which they pass: The passenger train movement over the Syracuse divi-

filled, the number of engine positions is not reduced. While the long pit will allow greater storage capacity for the same number of engine positions, nevertheless to utilize the maximum storage capacity of the long pit, the number of engine positions must be reduced for a portion of the time in order to completely fill it, thereby reducing the efficiency of the terminal from an ash pit standpoint. In the circular types, additional storage can be obtained by deepening the pit.

If an extension of plant is required, one or more pits may be added without disturbing the others. In view of the lesser lengths of track supported over or adjacent to the water, a much better opportunity is afforded for protection and a man

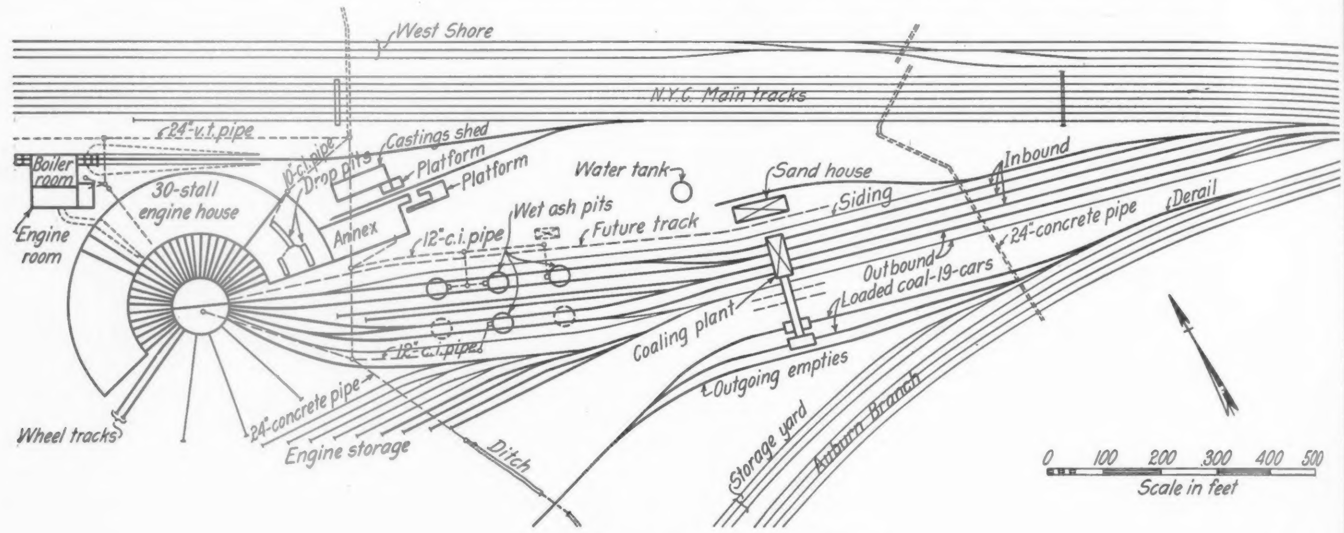
may cross between the engines without as great an element of risk. On account of the smaller first cost, it is reasonably economical to install pits with walkways on the water side rather than to leave them open or to install gratings.

The pits are designed to be cleaned by a locomotive crane with clam shell bucket, operating on a stub track adjacent to the pit tracks. In order to protect against damage from the bucket six rows of old rails 30 ft. long and on 24-in. centers have been imbedded in the concrete at the bottom of the pit with the ball of the rails slightly above the surface of the concrete. Each side of the opening between the 4 ft. walks on the inner side of the pit tracks has been protected by a series of 80-lb. rails bent at about a 30-deg. angle. These rails are vertical above the edge of the pit but slope toward the walls, thus forming guides for the bucket when it is withdrawn. Each alternate rail is extended and imbedded in the concrete sectors mentioned. The ends of the shorter lengths of the bent 80-lb. rails and the centers of the longer ones are tied together on each half of the pit by a length of 105-lb. rail paralleling the center line of the track while a second line higher up adds to the rigidity of the arrangement. A clear opening, 11 ft. wide, is secured. The extended vertical sections of the 80-lb. rails form the posts for the protective "railing" on the inside of the walks. The railing consists of ¾-in. steel cables run through holes drilled in the web of the rail and is carried around the ends of the pits by wooden posts, making a continuous protection. The two walkways are placed independently in the pit and are built of timber, easily removed and replaced.

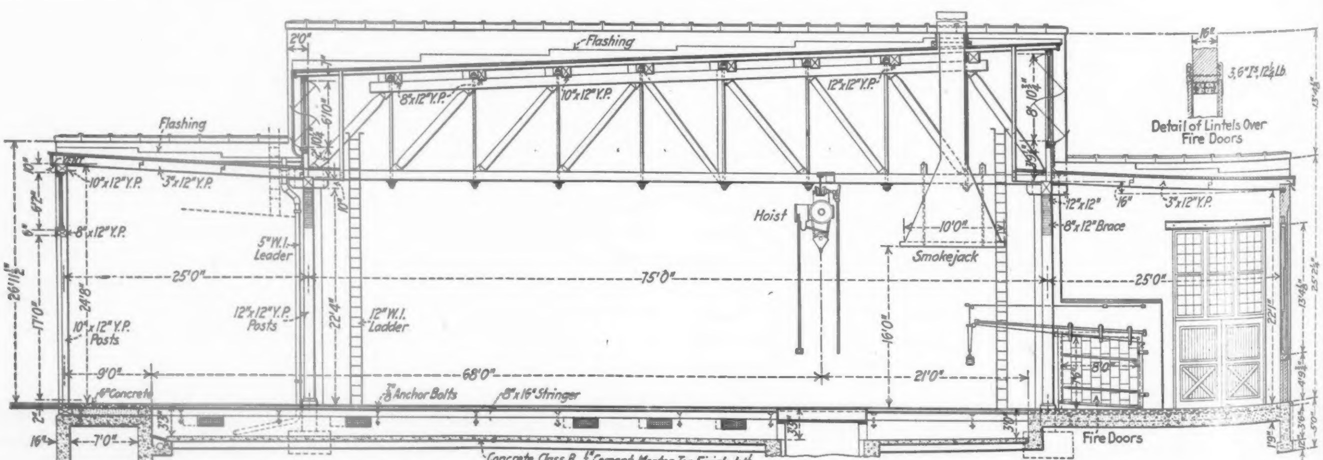
A Well Arranged 30-Stall Enginehouse

The type of enginehouse which has been built at Solvay is one which has become, in a way, a standard on the New York Central. This particular house is a 30-stall structure with mass concrete foundations, brick walls and fire walls, timber posts and a timber monitor roof structure.

The enginehouse is a semi-circular structure with an inner radius of 126 ft. 5 9/16 in. With the exception of five stalls at one end which are 125 ft. deep, all stalls are 110 ft. from center line of the door posts to the interior faces of the pilasters in the rear wall. One stall has been constructed as an outbound track through the building; this divides it into sections of 10, 14 and 5 stalls, respectively, each separated by fire walls. The angle between center lines of stalls is 6 deg. 48 min. for all except the outbound track mentioned where the angles to either side have been increased to 7 deg. 15 min. This gives an opening of 15 ft. center to center of door posts on 29 stalls and 16 ft. 11¾ in. for the outbound track, although this section has no doors at front or rear. Each stall is divided into three bays which, in the 110 ft. sections of the house, are 25 ft., 64 ft. and 21 ft., respectively, from the door end. In the 125-ft. 5-stall section they are 25 ft., 75 ft. and 25 ft. The roof is a timber structure carried on 12-in. by 12-in. yellow pine posts. The center bay forms the monitor and this section is supported by timber trusses between stalls. The trusses are reinforced with steel rods in the 125-ft. section, which is chiefly the repair section of the house and little affected by hot gases. The roof over each bay is of the shed type, the slope of the inner bay and



General Layout of the New Terminal



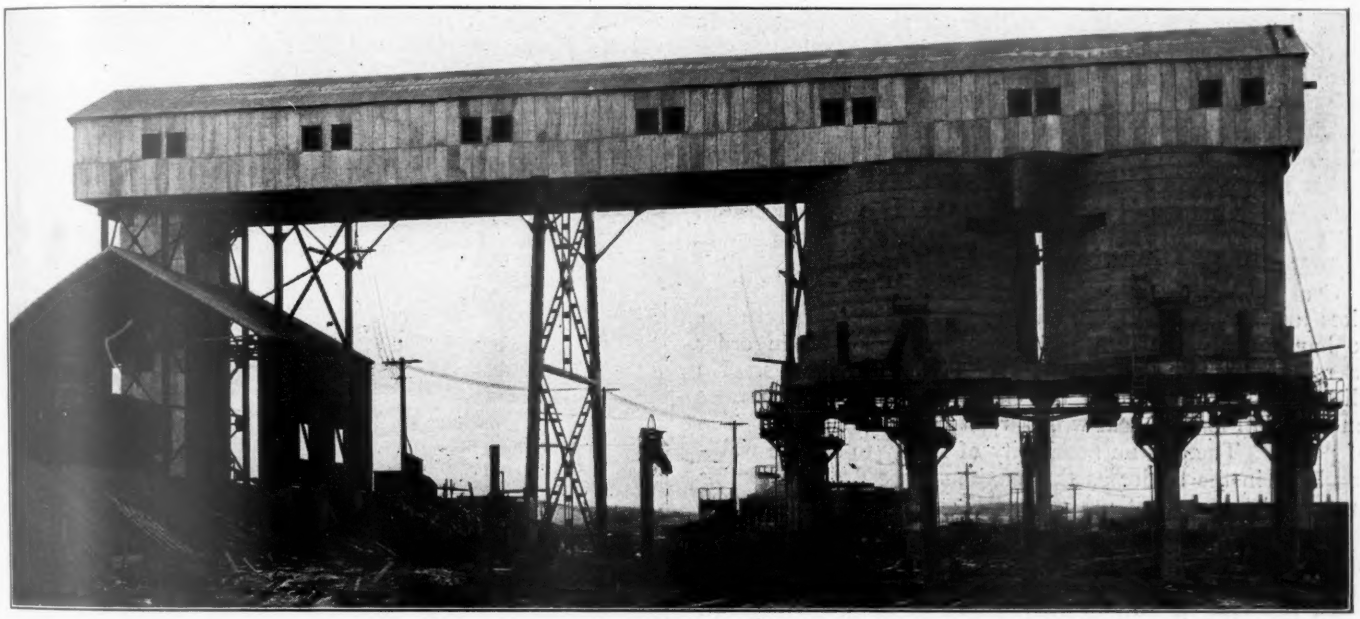
A Section Through a Standard 125-ft. Stall

the monitor being toward the first line of interior posts and of the outer bay toward the rear of the house. In the 125-ft. 5-stall section the entire roof structure has been raised slightly over five feet, thus increasing the clearance under the monitor section for the use of a monorail hoist of 7½ tons capacity. The effectiveness of the lighting was also improved.

Windows of large size have been installed in the rear and end walls, in both sides of the monitor and over the doors of the 125-ft. section. Smaller sash has been installed over the doors of the 110-ft. section. Daylighting is thus well taken care of, there being about 19,000 sq. ft. of windows in the enginehouse and in the 52-ft. by 92-ft. annex which includes the machine shop, offices, oil storage and quarters for engine crews. The interior electric lighting is also well taken care of. Besides three large drop lights between stalls, six drop lights have been provided in clusters of two with large reflectors, so arranged as to throw the light on each side of the locomotives. These lights are controlled by a switch arrangement on the rear wall. There are also numerous outlets for the use of portable lights. Another installation of interest electrically is the provision at each stall for the use of a portable electric welder.

The engine pits are of concrete, crowned slightly at the bottom and drain toward the inner and outer circles. The wheel pits have all been installed in the 125-ft. section, three tracks having driver wheel pits and two tracks having pony truck and tender pits. One wall of the pits forms one side of the hot air ducts through which the pits and the house are heated. These air ducts have five screened openings into each pit and connect at the inner circle with a large hot air duct which follows the line of the inner circle just below the floor system and inside the doors. It is of concrete of variable inner dimensions to secure the most efficient flow of the heated air. The two arms of this duct tap into the main heating duct from the power house adjacent to the enginehouse between stalls Nos. 18 and 19, the sides of the pits at this point forming the sides of the duct. The clear height at this point is about 7 ft. 6 in. The junction of the two arms is constructed to divert the air in the proper quantities. This is accomplished chiefly through a "V" or baffle wall located so as to give different dimensioned passageways to either end of the house. The entire enginehouse is floored with six inches of concrete, this flooring forming the top of all air conduits except the feeder extending around the inner circle, over which the enginehouse tracks pass. At these points a reinforced concrete slab 11½ in. thick forms the top and on this is placed 7½ in. of cinders and then the regular floor construction. As a precaution against engines going through the rear walls, an opening has been left in the floor back of the bumpers. This opening is covered with plank flooring which the pony trucks can easily break through, thus effectually stopping the engine.

In addition to the equipment mentioned for the enginehouse proper, each stall is provided with a link in the rear wall by means of which, in conjunction with a special motor and drum on the turntable, dead engines can be hauled into position. Another unit of interest is a portable oil and repair truck used by the enginehouse forces. This truck contains a generous equipment of tools, oils, grease, etc., necessary for the pit work and inspection on the engines. It also contains a special high candle-power inspection light which can be placed in the pit or at any other desired location, greatly facilitating the work. By concentrating all of the various needs of the locomotive, electrical, air brake and other inspectors, and the men and their helpers, it is estimated that a substantial saving has been made in time saved. A test indicated that the amount of walking eliminated by the foreman and his 11 men in one 8-hour period was the equivalent of 43 miles by one man.

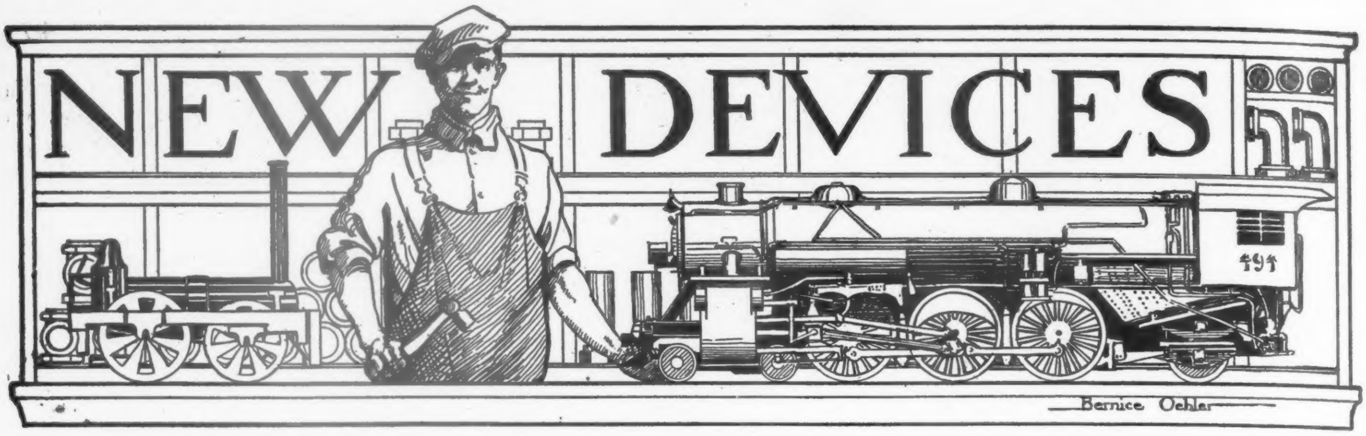


A Modern, Workmanlike Coaling Plant

The enginehouse, power house and machine shop are completely equipped with all necessary facilities where needed, arranged for easy access. The equipment includes three 400 hp. water tube boilers with space for a fourth unit, pumps, feed water heaters, boiler washing plant, hot air heating coils and large size blower, oil filters and an ash hoist and storage bin, etc. The power house has an inside trestle for coal cars.

A Large, Modern Railroad Designed Coaling Plant

The coaling plant is of reinforced concrete and steel throughout, making a fireproof structure with a rated capacity of 1,000 tons. The actual capacity appears to be somewhat greater than this. The entire design aside from the machinery was prepared by the engineering department of the road with the purpose, among other things, of facilitating the rapid construction of the plant. Coal is delivered in hopper-bottom cars operated by gravity over two tracks and is discharged into hoppers under the tracks from which it is elevated to a conveyor gallery. Duplicate hoisting and conveying machinery has been installed. The storage facilities are in the form of two circular concrete bins 33 ft. 8 in. inside diameter and 30 ft. 8 in. in height.



Changes in Design of Elvin Stoker

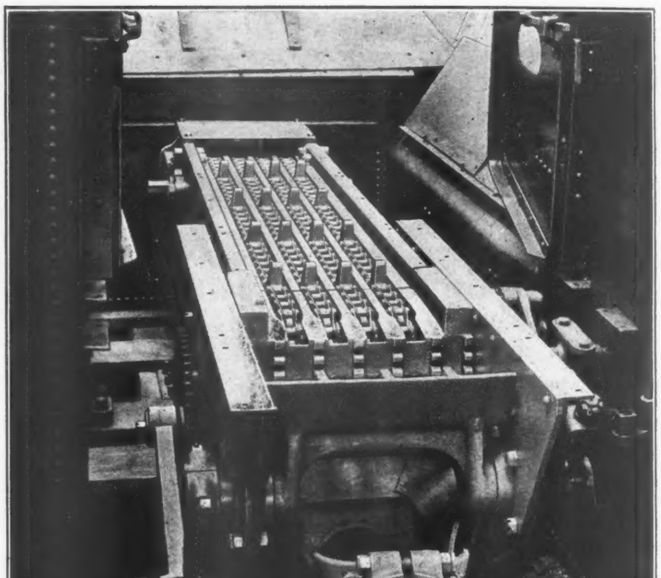
IN the original design of the Elvin Stoker a screw conveyor was used to carry the coal forward from the tender to the screw conveyor that delivers it to the elevator. In machines now being constructed, the Elvin Mechanical Stoker Company, New York, is applying an improved type of chain belt feeder combined with a reciprocating crusher.

The feeder consists of four endless drag chains in a wide, shallow trough. The rate at which coal is delivered to the stoker is governed by the speed of the chains which are fed forward intermittently at any rate required by the operator, delivering coal at any desired rate up to the maximum capacity of about seven tons per hour.

Coal which does not require crushing passes through four slots just back of the main crusher jaws, leaving the crusher to handle only the coal which requires breaking in order to reduce it to the proper size for the stoker shovels. No slide plates are used over the chains as the feeder operates under a full load of coal with a relatively small consumption of power. There is no possibility of injury to anyone walking back in the tender as the maximum speed of the chains is only about six feet per minute.

The crusher has a single crushing roll which revolves backward and forward through a partial revolution. The crusher is ahead of the coal gates and is not covered even when the tank is full of coal, being in plain view at all times during operation. Any obstruction in the crusher will stop the entire machine thus making its presence known. By reversing the stoker engine the crusher jaws can be opened allowing the foreign matter to be removed. The cover plate over the crusher is normally set at an angle to form a guard; when laid flat it forms a shovel plate for shoveling coal by hand on sidings or at terminals.

In order to compensate for the variable loads which are imposed by the crusher the stoker engine has been provided with a simple and compact governor apparatus. This operates on the hydraulic principle utilizing the varied pressure from a small gear pump to operate a balanced piston control valve. By means of the governor the stoker speed is maintained at any rate desired by the operator regardless of whether the fuel supply consists of slack coal or lumps or a mixture of both.



A View of Feeder and Crusher with Tender Deck Removed

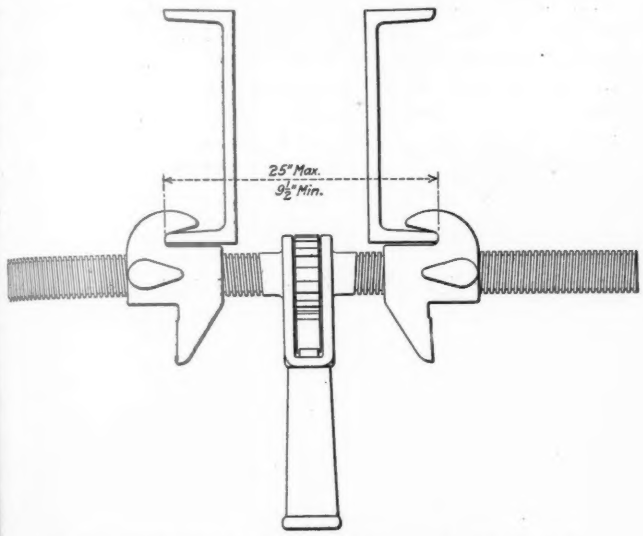
Electric Drill Provided with Mechanical Reverse

THE Independent Pneumatic Tool Company, Chicago, has placed on the market an electric drill which reverses by means of a mechanical device located in the gear case. The motor always runs in the same direction and is relieved of the severe shock which formerly resulted from reversing the current when the motor was under load and speed.

The reversing gear is equipped with a fool-proof locking device which can be shifted instantly to permit three motions: First, a locked constant forward motion for general drilling, reaming, stud driving, nut tightening and tube rolling; second, a locked constant reverse motion for backing off nuts and backing out studs and tube rollers; third, a neutral position which allows the spindle to slip into forward motion when the machine is pressed forward against the work and to slip into reverse motion as the machine is withdrawn from the work. This action is automatic, making the tool ideal for wood boring, tapping, flue rolling, and similar work. The patent, as applied for, covers the device on both electric and pneumatic tools of all sizes.

Push and Pull Jack for Car Work

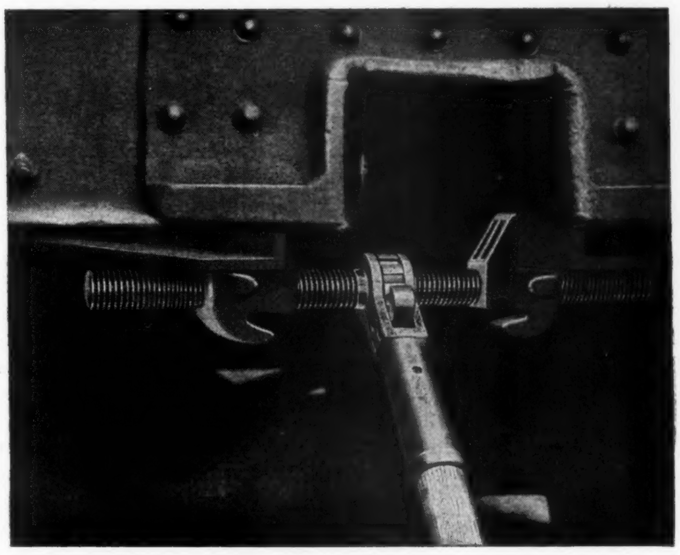
A NEW jack which should prove of exceptional value in car repair work has been developed and placed on the market recently by the Duff Manufacturing Company, Pittsburgh, Pa. The special feature of this jack is its arrangement to either push or pull at the will of the



Arrangement for Straightening Channels by Pulling

operator as shown in the illustrations. The jack can be used for straightening center sills on the draft gear ends of cars either by pushing apart or pulling together where bent. With chains and hooks it can be used to advantage for pulling in freight car sides which have been bent outward.

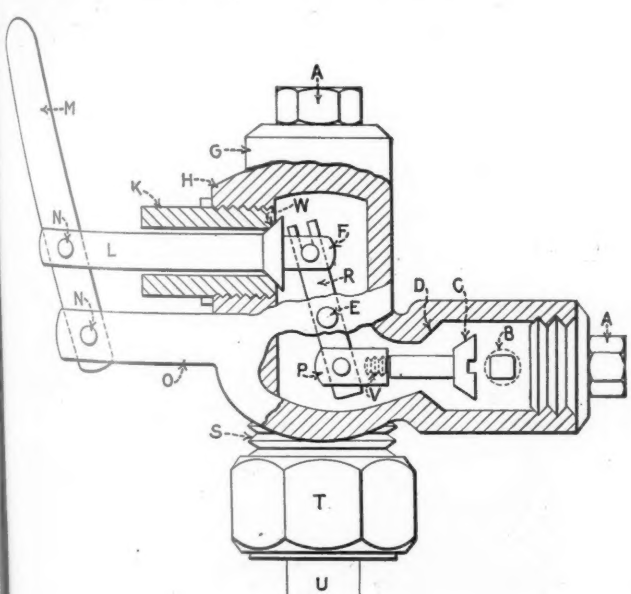
The jack is extremely simple in design, consisting of a steel screw, rachet with pawl, and two cast-steel nuts, the latter being designed with a flat projection on one side for pushing and a hook on the other side for pulling. The nut bearing has ample length for sustaining the eccentric stresses of both pushing and pulling. The jack weighs 39 lb. and has a capacity of 10 tons. For pulling, the maximum and minimum spreads are 25 in. and 9½ in. respectively. For pushing, the maximum and minimum spreads are 24 in. and 8½ in. respectively.



Duff Jack Which May Be Used for Spreading Car Center Sill

Locomotive Safety Water Gage Valve

AN automatic, safety water gage valve, which has given dependable and satisfactory service for more than five years on stationary boilers, has recently been installed successfully on locomotives by the Mattingly Automatic Valve Company, St. Louis, Mo. The action of this valve is as follows, reference being made to the illustration wherein *C* represents the main valve controlling the passage from boiler to gage glass. *R* is a link pivoted on pin *E* which extends through from one side of the casing to the other. *R* forms a connection between main valve *C* and auxiliary valve *W* and causes main valve *C* to be moved in the opposite direction to that of auxiliary valve *W*, thus preventing both valves from being seated at the same time. *L* is the auxiliary valve stem, the inner end of which is connected to link *R* by means of a fulcrum and pin which fits in the slotted end of link *R*. Valve stem *L* slides through bushing *K*, the bore in bushing *K* being somewhat larger than the valve stem. This allows a passageway around valve stem *L* which is controlled by auxiliary valve *W*, thus eliminating the necessity of any packing around this stem. To the outer end of auxiliary valve stem *L* is connected a lever *M* called the operating lever, the position of which indicates the position of the main valve *C*. When the lever is leaning outward the main valve *C* is off its seat and when the operating lever is leaning inward it indicates that the main valve *C* is closed.



Mattingly Automatic Safety Water Gage Valve in Open Position

The construction of the valve casing, as illustrated, provides a boiler connection at right angles to allow for cleaning the interior of the valve and inserting a rod or wire into boiler through plug *B* and lower plug *A*. The portion of casing marked *G* is offset from the portion marked *H* to allow for a glass or metallic water glass end being inserted from the top through the upper plug *A*.

When either the top or the bottom water gage valve is opened, as shown in the illustration, the pressure is admitted around main valve *C* through the gage glass and into the

valve at the opposite end of the glass. This pressure quickly equalizes on each side of the main valve C and at the same time exerts itself against auxiliary valve W and stem L forcing them outward until auxiliary valve W rests on its seat. In other words, when one valve (either top or bottom) is opened to admit pressure from the boiler, this pressure automatically passes through the gage glass to the other valve and forces it wide open, holding it open. Should either valve be placed in closed position while the other one is open, it will not stay in that position, but will open again. This is due to the pressure acting against the auxiliary valve and stem as above mentioned.

To close the valves while pressure is in the glass, move them both to closed position at the same time. This allows both main valves C to close communication between the boiler and glass, at the same time unseating auxiliary valves W. This allows the pressure in the glass to escape around auxiliary stem L which has no packing around it. Should the gage glass become broken, the pressure will be quickly released off auxiliary valve W and the pressure rushing from the boiler will force main valves C to their seats instantly stopping the flow of escaping steam and water.

A valuable feature of this valve is the practical impossibility of its sticking or corroding shut. The valve is manually operated and gravity is not depended on to close it. Should dirt or grit become lodged on either valve seat causing a leak, it can usually be dislodged by pushing the operating lever in and letting it fly back.

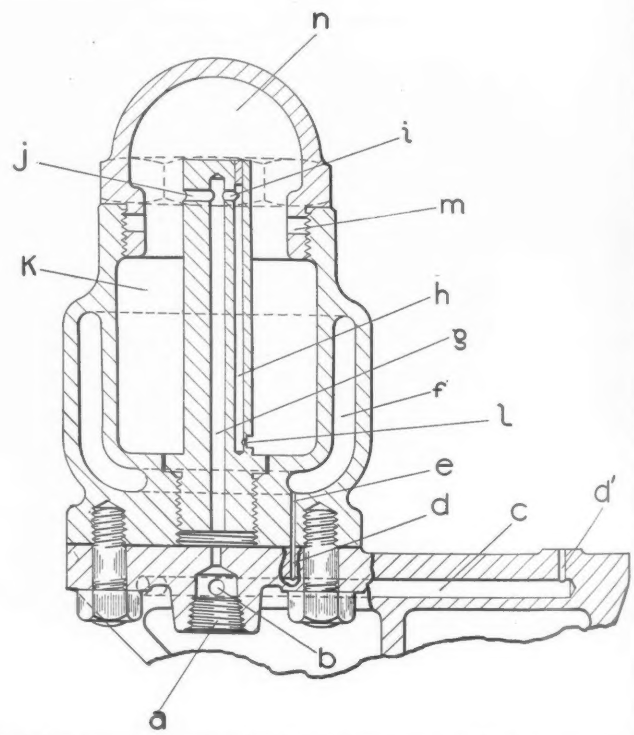
Oil Atomizing Lubricator for Air Compressors

An atomizing lubricator for all types of air compressors —cross-compound, duplex and simple—has been perfected recently by the New York Air Brake Company, New York. A unique feature of this lubricator is the provision for securing practically uniform temperature of the oil and consequently a uniform feed to the air cylinders. This is obtained by surrounding the oil chamber with an air jacket in constant communication with the high pressure air cylinder of a cross-compound or duplex compressor, or with the air cylinder of a simple compressor should it be of this type. As a result, the hot compressed air in the jacket so warms the oil that there is little difference in the rate of feed in summer or winter, while it will handle equally well either light or heavy oils.

Referring to the ilustration of one of these oil cups and a portion of its supporting bracket, the pipe-tapped opening a is connected by a ⅜-in. O. D. copper pipe to the high pressure air cylinder, provided the compressor is of the compound or duplex type. Hot, compressed air, entering at a, flows through passages b, c and d to the jacket chamber f, also through b, c and d' to a second oil cup for the compressor cylinder not shown in the illustration.

These cups are fastened by studs to a bracket attached to the top head or to the center piece of the compressor. Oil, after passing through the restricted port l is drawn up through passage h and into i, where it meets incoming air drawn back by the suction stroke of the air piston. After being atomized it goes down through passage g to the air cylinder.

This oil cup is simple in construction, without moving parts, and requires a minimum of attention during road service. It is entirely automatic in its operation, and without valve or adjustments, the rate of feed being determined by the relative size, position and arrangement of the several ports and passages.

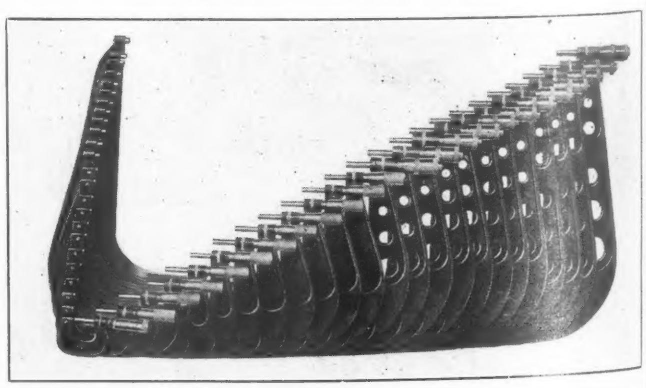


Lubricator with Bracket for Cross-Compound or Duplex Compressor

Micrometer Calipers with Rectangular Frames

Of particular interest to mechanics, tool makers and practically every user of measuring instruments is the new line of Rex micrometers made by the Brown & Sharpe Mfg. Co., Providence, R. I. This Rex line is furnished for either English or Metric measure and includes 24 different sizes of micrometers to take measurements up to 24 in. or 600 mm. The illustration shows a complete line of 24 sizes of Rex micrometers, in progression from the No. 59, measuring 0 to 1 in. to No. 88, measuring 23 in. to 24 in. These micrometers are regularly furnished with a clamp ring which clamps the spindle and preserves the setting.

A feature of the micrometers is the rectangular shape of the frames which gives greater measuring capacity than frames of the circular type. Holes are used in the larger sizes to lighten the frames. The anvil, spindle and other



Brown & Sharpe Micrometer Calipers Featured by Light but Strong Rectangular Frame; Ranges; Range, 1 in. to 24 in.

parts of the Rex line are similar to the parts of the regular Brown & Sharpe micrometer calipers. Means are provided for adjustment for wear of measuring surfaces and screw.

In the larger sizes, Rex micrometers are supplied with finished wooden cases, substantially made and affording a safe place in which to keep the tools.

Radial Drill Equipped for Side Rod Boring

An interesting side rod boring operation is performed on a 6-ft. plain, triple purpose, radial drill built by the American Tool Works Company, Cincinnati, Ohio. The slow speeds for this and similar boring and tapping operations are obtained through an internal gear drive on the spindle, which provides the power and rigidity necessary for this class of work.

Powerful American Radial Drill Equipment for Boring Side Rods

The side rod boring equipment consists of a pair of parallel T-slotted rails, bolted across the base, upon which is mounted a heavy housing carrying a bronze guide bushing to aline the overhung spindle close to the cutter head. Mounted in the spindle is a cutter head or trepanner, which consists of a hollow steel shell carrying three cutters. A taper shank and cross drive key fit the spindle and the dead weight of the tool head is carried on a cross pin in the spindle nose. The tools are shaped so each one removes a certain portion of the material with the result that the slot is cut through the steel forging in a remarkably short time, leaving the center plug shown for some other purpose.

The cutter head is arranged to carry an auxiliary adjustable boring tool (not shown) for taking the finishing cut after removing the center plug. The extension of the parallel rails in front of the housing provides the holding means for securing the work. The rod illustrated was an annealed open-hearth steel forging of .40-.50 carbon and .50-.70 manganese content. The hole bored was 11 3/16 in. in rough diameter, being finished to 11¼ in. diameter. The rough cutting time was 23½ min. at the rate of 12 r.p.m. with .016-in. feed. The finish cut took 42 min. at 22 r.p.m. and .005-in. feed.

An outboard arm support was used in early experiments but was found to be superfluous as the arm and column were entirely free from deflection or chatter without it.

The great power delivered to the spindle of this drill enables it to perform operations never expected of radial drills before and makes it a more useful and general purpose machine, especially adapted to railroad shop use.

Die Head with Micrometer Attachment

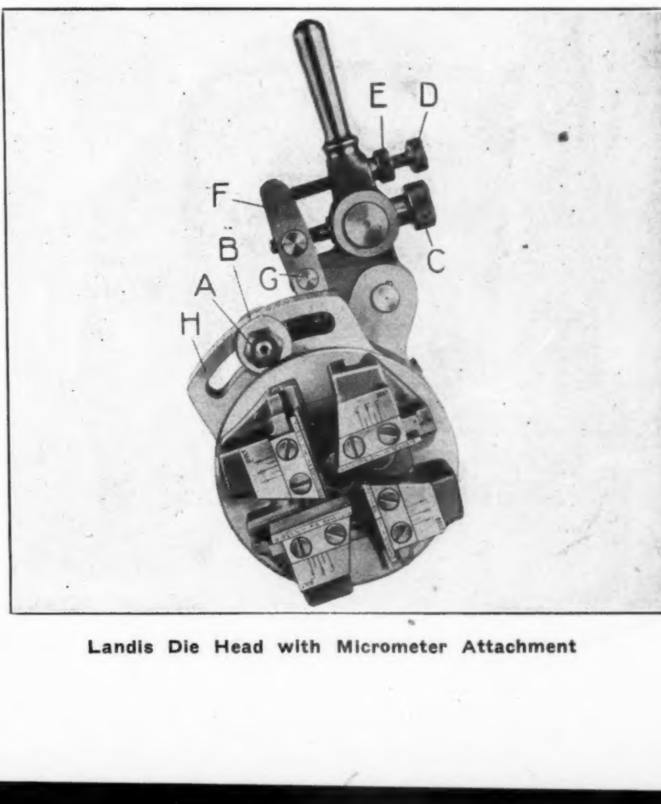
The Landis Machine Company, Waynesboro, Pa., has recently developed a stationary type die head with micrometer attachment. This head is particularly valuable when cutting threads of special form requiring one or more roughing cuts and a finishing cut. With the micrometer attachment it is possible to set the die head so that the same amount of metal is left for the finishing cut at all times. The head is graduated for both right and left hand for all sizes of bolts and pipe within its range. These graduations are stamped on the outer surface of the closing ring above the circular slot.

The operation of the die head, referring to the illustration, is as follows: To adjust the die head to size loosen the clamping nut *A* with the left hand and bring the index mark *B* opposite the required graduation on the graduated scale with the right hand. Further adjustment can be made, if desired, through the micrometer attachment and great accuracy attained.

To adjust the micrometer attachment back off stop screw *D* after first loosening the stop screw lock nut *E*. Then the micrometer screw *C* can be adjusted for increasing or decreasing the diametrical adjustment.

To increase the diametrical adjustment of the die head, turn the micrometer screw *C* in a counter clockwise direction. This causes the upper part of the link *F* to swing to the left about the center *G*. The swing of the link *F* to the left pulls the closing ring *H* to the right and increases the diametrical adjustment. Turning the micrometer screw *C* in a clockwise direction causes a counter movement of the link *F* and decreases the diametrical adjustment.

After the micrometer adjustment is made, the stop screw



Landis Die Head with Micrometer Attachment

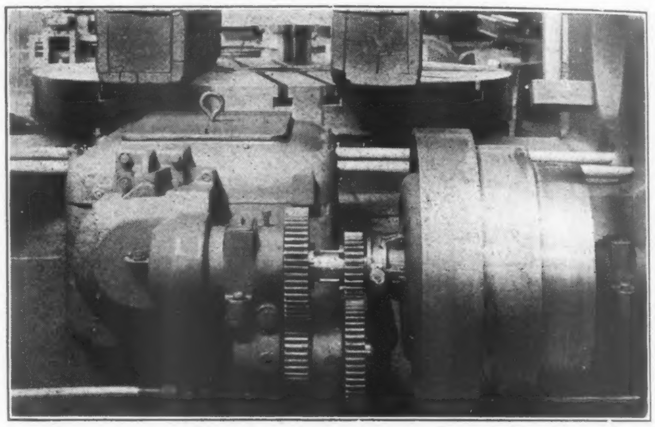
D should be set against the link *F* and locked in place with the stop screw lock nut *E*. To adjust the die head for the roughing cut, turn the micrometer screw *C* in a counter clockwise direction until the desired diametrical adjustment is obtained. The stop screw *D* should be left in the locked position. Two or more roughing cuts can be made by decreasing the diametrical adjustment of the die head in one or more increments through the micrometer screw *C*. After the roughing cut has been made, the micrometer screw C should be turned back in a clockwise direction until the link *F* comes against the stop screw *D*. The die head is now set to the final diameter and is ready for the finishing cut.

Arrangements can be made to apply this die head with micrometer attachment to turret lathes, engine lathes, and hand-operated screw machines. It may also be applied to lathe types of threading machines having stationary heads.

Slow Speed Device for Boring Mill

A SLOW speed device for a seven-foot boring mill has been developed by the Cincinnati Planer Company, Cincinnati, Ohio, as shown in the illustration. This mill is designed for boring locomotive driving boxes and other parts at a speed about 30 per cent greater than standard. In order that tires may be turned on this same mill, a slow speed of about ⅔ r.p.m. is required, this speed being obtained by means of the special gearing illustrated.

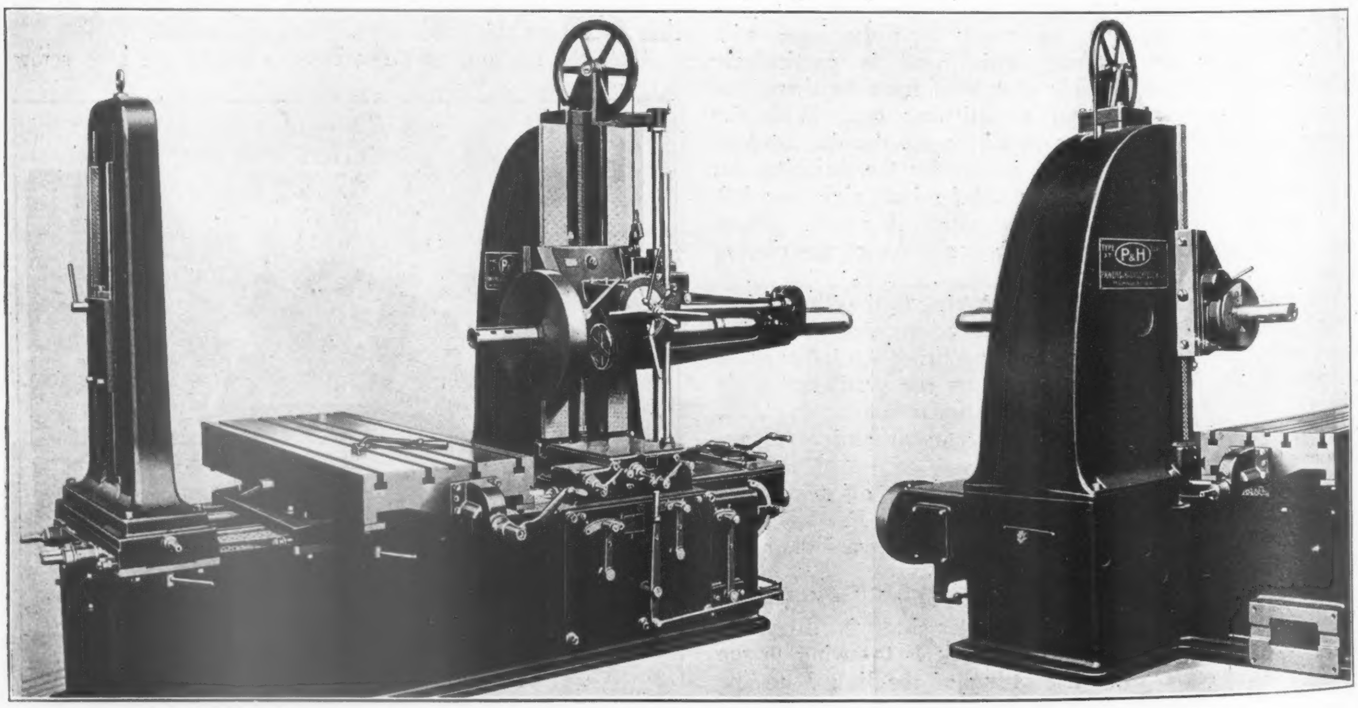
A direct drive for the standard boring mill speeds is obtained when the small upper gear is slid to the left, bringing its clutch teeth in mesh with those of the large gear on the same shaft. The standard arrangement for starting and stopping the mill consists of the friction clutch, shown at the right of the gearing. A special cover has been made to protect all the gearing, also carrying the shifter for moving the sliding gear back and forth. By means of this arrangement an unusually slow table speed can be obtained.



Slow Speed Device Applied to Seven-Foot Cincinnati Planer

Table Type Horizontal Boring Machine

SINCE bringing out the horizontal boring, drilling and milling machine, described on page 657 of the October, 1921, *Railway Mechanical Engineer*, the Pawling & Harnischfeger Company, Milwaukee, Wis., has developed a machine of similar type but with a table and outer support mounted on ways instead of the original bed plate. This machine is designed for toolroom as well as production work. The new machine is modern in construction, being designed to perform boring, drilling and milling operations with great accuracy. It is said that in milling a 22 in. square surface, the accuracy is within .001 in. This accuracy is made possible by the use of a square lock, narrow guides with taper gibs and unusually heavy construction of the spindle, saddle and column, coupled with scraped sliding fits. All sliding parts are arranged with take-up for wear. The saddle is fully counterbalanced with a counterweight located inside of



Pawling & Harnischfeger Horizontal Boring Machine, Equipped with Large Face Plate (left) and Small Face Plate (right)

the column. Further features include centralized control, externally and internally driven face plates which are interchangeable, and automatic stops for the saddle and platen. All operating levers are within easy reach of the operator, the respective movements being interlocked so that conflicting speeds or feeds cannot be set in action at the same time. The drive for this machine is delivered to the spindle through a large face plate with internal gear and tapped holes for the attachment of milling cutters and facing heads, or a small face plate with a wide face, coarse pitch gear. These two arrangements are shown in the illustration. A 14-in. driving pulley running at 350 r.p.m. is used on this machine giving 16 spindle speeds ranging from 14.5 to 225 r.p.m. with the small face plate. Speeds from 8.7 to 136 r.p.m. are available with the large face plate. Power is transmitted by a belt directly from the line shaft to the pulley on the machine itself. A 5-hp. constant speed motor, operating at 1,200 to 1,400 r.p.m., is recommended.

Eight geared feeds ranging from .005 to .288 in. per revolution of the spindle are available for boring and from .0084 to .44 in. per revolution of the spindle for milling when using the small face plate. When using the large face plate the feeds range from .008 to .48 in. per revolution of the spindle for boring and .013 to .73 in. for milling.

Combination Frame Planer and Slotter

A UNIQUE machine has just been placed on the market by the Liberty Machine Tool Company, Hamilton, Ohio, in the combination planer and slotter for locomotive frames, illustrated. Obviously, this arrangement saves floor space and considerable work in moving locomotive frames from one machine to another and setting up the frames. The standard 36-in. Liberty planer, which can be provided with four heads if desired, is the essential part of the new machine to which a slotter arrangement is added. The bed of the machine is 69 ft. long, the table being 38 ft. long and 30 in. wide. Both the bed and housings are of the box type, the method of bolting the housings to the bed and connecting them at the top by a heavy cross brace being in accordance with standard Liberty planer construction. The distance between the housings is 37 in.

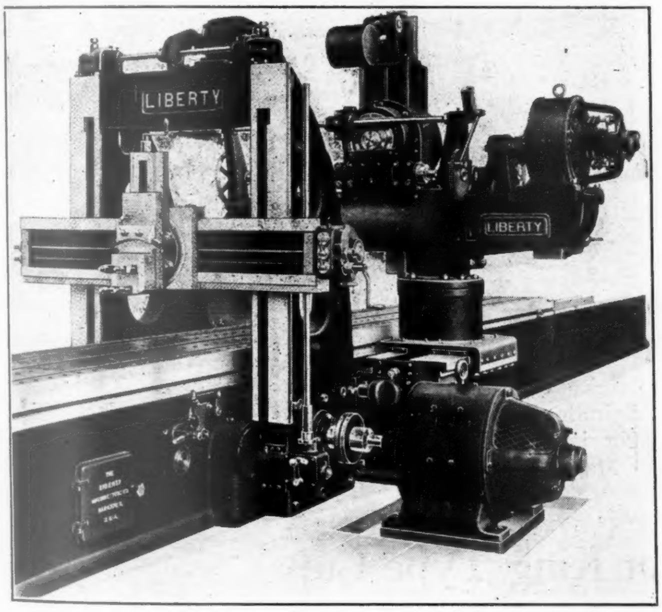


Fig. 1—Liberty Frame Planing and Slotting Machine

As shown in Fig. 1, the planer rail-elevating device is located at the center of the top brace, both elevating screws being driven from the top and supported on ball bearings. The elevating device is controlled by a handle at the side of the housing. Power for feeding the two heads is taken from the bull pinion shaft through a spur gear and mitre gears to the vertical splined feed shaft. Arrangement can be made for the feed to take place on the forward or return stroke by means of a small handle which can also be used to disengage the feed. The feed of the rail heads can be changed at any time without stopping the machine or interfering with the feed of the side heads. The amount of feed is indicated by a dial for the convenience of the operator. Owing to the length of the machine bed the operator would lose time if he had to go around it frequently. A desirable feature of the new machine is the arrangement to make all speed and feed changes from either side. The planer part of the machine is driven by a 15-hp. reversing motor but if desired, belt drive can be provided with aluminum pulleys having cast-iron centers.

The slotter arrangement, best illustrated in Fig. 2, is a self-contained unit rigidly bolted to the bed of the machine and allowing a 24-in. lengthwise travel of the ram. The design is such that the cross rail can be swiveled on a column when it is necessary to slot at an angle across the bed. The cross rail can also be swung clear of the table when using the machine exclusively for large planer work. The left end of the slotter rail is supported on a housing which moves with the right housing. Clamps are provided on the left housing for locking the rail when adjusted to the proper angle.

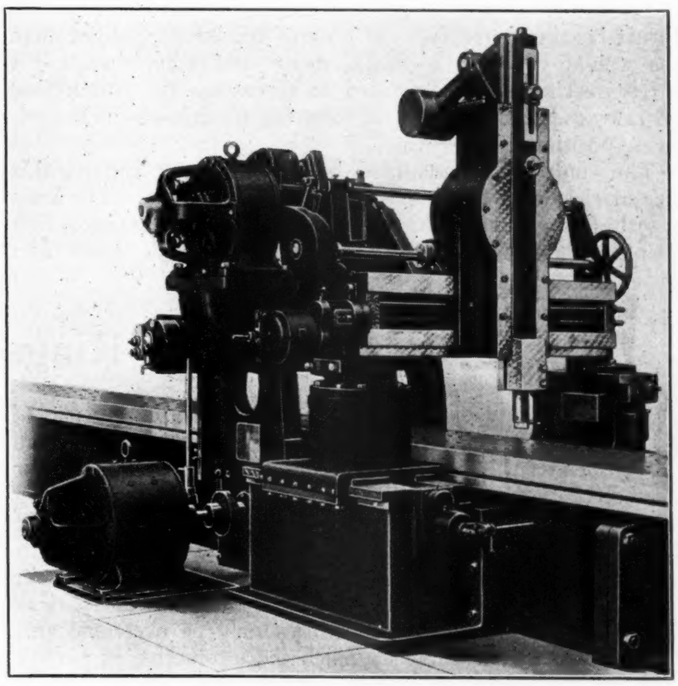


Fig. 2—View Showing Slotter Arrangement

Independent automatic feed and rapid traverse for the head on the cross rail and lengthwise of the base is provided. The ram is driven by a worm and worm wheel through a crank disk and connecting rod, the power being secured from a 10-hp. variable speed motor mounted on the end of the cross rail as illustrated. Power for operating the rail and head movements is secured from two smaller motors. The

stroke of the ram is adjustable up to 14 in., the clearance between the slotter housings being 37 in. and between the slotter cross rail and planer bed, 18 in. The planer table is stationary when slotting and when the cut is completed the table can be quickly and easily moved to the next position. Attachments can be furnished for circular feeding or cutting fillers.

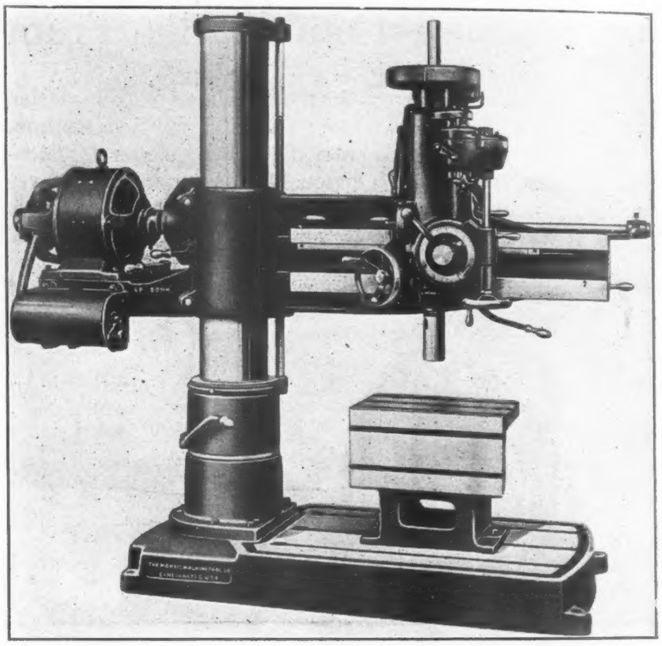
The overall height of the machine is 10 ft. 11 in., the floor space occupied being 10 ft. 2 in. by 78 ft. The weight is 69,000 lb.

New Motor Drive for Radial Drill

The illustration shows a Morris 4-ft. and 4½-ft. radial with the driving motor mounted on the back of the arm. The construction is simple and has the following advantages: There is a saving of power from 20 to 25 per cent due to the fact that the lower shaft, bevel gears in column, shaft in column, gears in column cap, outside vertical column shaft and the bevel gears in back of the arm are eliminated. Besides the saving of power to drive these parts, there is just that much less mechanism to wear or get out of order. There is also the advantage that in mounting the motor in this way, it balances the arm permitting the arm to raise and lower on the column without exceptional strain on the arm-raising and lowering mechanism.

An important feature in the Morris radial of this design is that the arm raising and lowering mechanism is mounted as a unit on the back of the arm near the motor drive gears and is only in operation when the arm is being raised and lowered. For this reason the mechanism was removed from the column cap as this meant the constant running of a pair of bevel gears, a vertical shaft in back of the column and a few gears on the column cap as long as the machine is running, or the mounting of an extra motor to raise and lower the arm. On the Morris design the screw is stationary. The revolving unit is of bronze and mounted on a ball thrust bearing large enough to carry considerably more than the weight of our arm, head, motor and other details. A safety mechanism is provided to disengage the clutch that operates the arm raising and lowering mechanism at the extreme positions of the arm.

The controller is mounted below the motor and on this size machine is within easy reach of the operator. The head has the same features as on other Morris radials, including tapping the attachment running in oil, back gears and clutches made of nickel steel, heat treated and hardened, helical spindle gears, and all bronze bearings with oil chamber, permitting ample lubrication.



Morris Radial Drill with Single Driving Motor Mounted on Arm Extension

Spindle speeds are from 26 to 450 r.p.m. A 3½-hp. motor is required. This radial drill is manufactured by the Morris Machine Tool Company, Cincinnati, Ohio.

Solid Packing Rings for King-Type Cups

One of the great difficulties encountered in the use of metallic packing rings for King type cups arises from the fact that the packing must be divided into two or three sections. Holding these sections together while boring out the packing is a matter requiring considerable care and there is also a heavy loss of material because of the ease with which the thin edges of the sections become bent or broken in handling between the manufacturer and the point of application. In order that these difficulties may be overcome and that each set of packing may reach the locomotive in perfect condition the Jerome-Edwards Metallic Packing Company, Chicago, has developed and patented a method of packing and delivering Jerome packing for King type cups whereby the packing reaches the shop in a solid ring. In the final process of manufacture before the packing is prepared for shipment the three sections of each ring are sweated together and are intended to remain in this condition until the ring has been bored out and is ready for application.

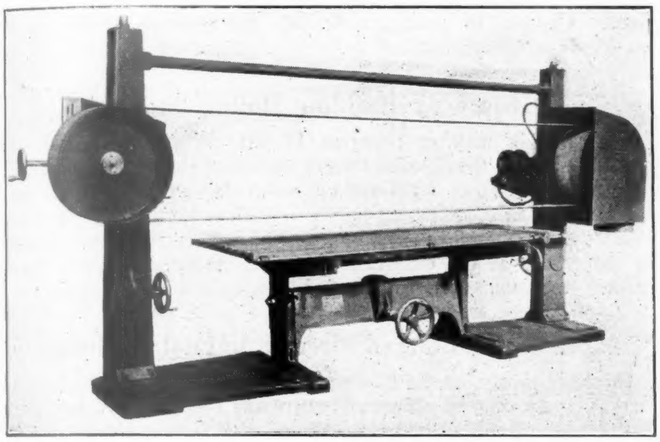
The box in which the ring is packed contains a small quantity of waxed excelsior and three small blocks which support the ring slightly above the bottom of the box. When the ring is ready to apply it is replaced in the box and a match touched to the excelsior, which in burning produces sufficient heat to melt out the solder in the joints without injuring the

Sweated Packing Ring Packed in Carton with Waxed Excelsior

sections themselves. This requires from three to five minutes, after which the sections fall apart. They are then wiped clean of the fused solder and are ready for application to the rod in perfect condition.

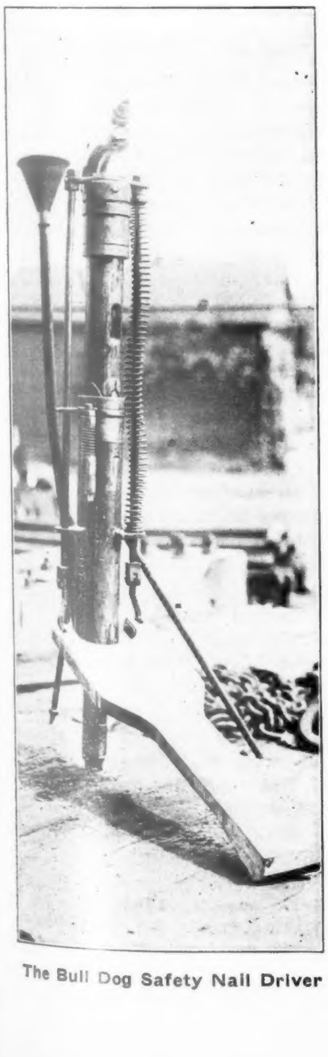
Self-Contained Belt Sanding Machine

A MACHINE designed for rapidly sanding and polishing all kinds of straight, flat and irregular surfaces as well as polishing metal surfaces has been placed on the market recently by the Oliver Machinery Company, Grand Rapids, Mich. This sander will take work of any length and sand to the center of 72 in. Work up to 42 in. high can be handled on the table of the machine illustrated and by removing the table, work up to 66 in. high from the floor can be accommodated. This arrangement makes the machine extremely flexible and adapted to a wide range of work. The table travels 36 in. horizontally, the vertical adjustment being 14 in. The belt is about 31 ft. long and can be provided in any width up to 10 in.


Belt Sanding and Polishing Machine for Wood or Metal Surfaces

The pulleys of this machine run on ball bearings. The machine is said to be conveniently operated and an exhaust hood on one wheel and guard on the other are valuable safety features. The table rolls on ball bearings and there are no gravity idlers in connection with the machine. A reversible switch permits the belt to run in either direction. The table is fastened to the base plates of the stand which are connected overhead with a rigid bar or top stay. The sand belt pulleys run in ball bearings for individual vertical adjustment on graduated ways by means of a hand wheel, beveled gears and screw. The pulleys are rubber faced and recommended to run at 600 r.p.m. Owing to the relatively large diameter of the pulleys the belt life is increased.

A Pneumatic Nail or Spike Driver


The Bull Dog Safety Nail Driver

AN application of the pneumatic hammer to the driving of nails and spikes in floor and bridge work has been made by the Dayton Pneumatic Tool Company, Dayton, Ohio, in a recently developed device known as the Bull Dog Safety Nail Driver. The tool consists of a barrel or cylinder with a small nozzle at the lower end, in the top of which is fitted the body of a pneumatic hammer. The hammer is free to move up and down in the barrel and is normally held in the raised position by a long coil spring. A foot pedal is attached to the top of the hammer by two rods which pass through guides on the barrel. Pressure on this pedal lowers the hammer into the operating position against the compression of the coil spring. A chute, the top of which is located at a convenient height near the hammer handle, leads down to the lower end of the barrel and feeds the nails into the nozzle. The device has no magazine, the nails being dropped into the chute one at a time as the device is placed in successive locations.

After a nail or spike has been dropped into the chute the hammer is lowered with the pedal and the spike driven home by opening the usual type of trigger valve in the hammer handle. The pedal is then released and the momentum of the hammer, raised by the coil spring, is sufficient to permit the whole device to be lifted and moved to the next location with very little effort on the part of the operator.

The device has a capacity ranging from 2-in. nails to 8-in. spikes and will drive from 40 to 60 6-in. spikes per minute. With it, it is said that two men, working in the standing position, can spike the floors on 15 cars a day, entirely free from the danger of flying spikes. Nails may be driven either flush or with set, as required.

The illustration at the left shows the Bull Dog safety nail driver ready for operation and indicates plainly the nozzle through which nails are fed to the lower end of the barrel. The illustration at the right shows the device with the operator standing on the foot pedal. Pressure on the trigger valve will operate the hammer and drive the spike.


The Hammer in Operation

GENERAL · NEWS

German Car Plant Burns

According to press dispatches from Berlin, the Orenstein & Koppel Works, builders of cars, was completely destroyed by fire on July 16.

Rumanian Railway Repair Shops Increase Output

The Rumanian railway repair shops, it is reported, are daily increasing their locomotive repair output. At present they are turning out 100 to 120 locomotives a week and it is believed that this figure will soon be exceeded.

Poland's Freight Car Requirements

Colonel A. B. Barber, American technical adviser to Poland, writing in "Poland," the journal of the American Polish Chamber of Commerce, estimates that the Polish railways will need to acquire between 110,000 and 120,000 freight cars during 1922.

"The Pennsylvania News"

On July 1 the Northwestern Region of the Pennsylvania issued the first number of its "Pennsylvania News." It is an eight-page tabloid size newspaper, four columns to the page. It will be published every two weeks and distributed to each of the 18,500 employees of that Region.

Reduction in British Railway Wages

Owing to the fall in the cost of living in Great Britain, the railway workers' war bonus has been reduced by 4 shillings (about 97 cents at the normal rate of exchange) per week. However, a number of classes have not been affected by this reduction, as they have already reached their standard of wages.

Bad-Order Cars

The number of bad-order freight cars was reduced from 15 to 14.6 per cent of the total from June 1 to June 15, according to the semi-monthly report of the Car Service Division of the American Railway Association. The number was 332,681, of which 268,305 required heavy repairs.

Freight Car Surplus

The freight car surplus for the period June 15 to 23 showed a reduction to 255,685, according to the report compiled by the Car Service Division of the American Railway Association, and for the period June 23 to 30 there was a further reduction to 239,225.

Wage Statistics, April, 1922

For April, 1922, the number of employees reported by Class I railroads was 1,578,133, an increase of 7,975, or 0.5 per cent over the number reported for the preceding month, according to the monthly bulletin of the Interstate Commerce Commission. Owing to a decrease in the number of the higher paid employees, the total compensation decreased $13,291,337, or 6.1 per cent.

Large Expenditures for Rolling Stock Disapproved in Italy

With regard to the credit of 1,750 millions of lire granted with a decree of the Italian Council of Ministers to the Italian State Railway Administration for the purchase of rolling stock and other supplies it is now learned that the parliamentary's committee for public works has not approved the above mentioned decree and that it has observed that at least one part of such material could be obtained in Germany on account of reparations.

It is known in this connection that it had been decided to grant such credit in order to aid industry, and that manufacturers are urging that the government refuse to accept from Germany machinery and manufactured products on account of reparations. Up until the present time Italy has received from Germany on the reparation's account only 50 locomotives.

Germany Building Rolling Stock

Germany is making progress in the construction of rolling stock. Already the 150,000 freight cars and the 5,000 locomotives delivered to France by Germany after the armistice have been replaced by new equipment and it is estimated that by August 1, 1922, the German railways will be in exactly the same position as they were at the outbreak of war as regards the quantity of rolling stock and even better off as regards the quality.

Interesting Colored Firemen in Fuel Economy

In connection with the fuel economy campaign on the Central of Georgia a meeting of colored firemen was recently held at Columbus, Ga., at which an address was delivered by Dr. M. L. Taylor. Dr. Taylor is a physician, one of the prominent colored citizens of Columbus and one who exerts a great deal of influence with the members of his race. It is sometimes difficult to secure the interest of colored firemen and Dr. Taylor's talk, which was widely commented on and was published in the Right Way Magazine, has served as a further encouragement to these employees in the efforts to save fuel.

A Central Purchasing Bureau for Polish Railways

A department called the "Centraine Biuro Zakupow" has been established at the Polish Ministry of Railways, which will be entrusted with the purchase for the railways in Poland of all material necessary for their operation. At the present moment orders for rolling stock and bridges, etc., will not be dealt with by this department, the activities of which will be limited to the purchase of rails, metals, lubricants, india rubber goods, asbestos, glass, etc. It is understood that the proposal is to extend this department gradually, and for it to undertake subsequently the purchase of all the requirements of the Ministry.

Freight Car Loading

The number of cars loaded with revenue freight showed another large gain during the week ended June 24 to a total of 877,856, as compared with 775,447 during the corresponding week of 1921, and 911,503 in the corresponding week of 1920. The gain over the preceding week was 17,084 cars and the fact that unusually large increases had been shown in earlier weeks indicates that instead of holding back freight to await the 10 per cent reductions in freight rates on July 1, as had been considered probable, some shippers may have hastened their shipments because of the threatened railroad strike.

The number of cars loaded with revenue freight for the week ended July 1, which was the last week before the 10 per cent reduction in freight rates took effect, as well as the last week before the shopmen's strike, was 876,896, or 960 less than the total for the preceding week. This was, however, an increase of over 100,000 as compared with the corresponding week of 1921, when the loading was 776,079 and only 14,725 less than the loading for the corresponding week of 1920, which was 891,621.

Freight car loading during the week ended July 8 showed the effect of the Fourth of July holiday by a reduction to 718,319 cars, as compared with 876,896 the week before but this still represented an increase of 77,784 as compared with the corresponding week of 1921, which also included a holiday, when the loading amounted to 640,535 cars. In the corresponding week of 1920 the total was 796,191.

Large Expenditures by Indian Railways

An expenditure of $85,000,000 annually for five years was recently recommended by the Indian railway finance committee as a minimum requirement. The estimate calls for 437 locomotives during each of the five years and 62,000 passenger and freight cars over the entire period, according to Consul North Winship, Bombay.

The shortage of cars has checked the coal mining and other industries, and it is proposed to double track many lines, strengthen bridges, remodel yards, and generally make the system equal to the needs of the country's growing traffic.

Decisions Under Federal Employers' Liability Act

The Illinois Supreme Court holds that an employee engaged in interstate commerce work, killed in a collision while going from the yard to his home on a hand-car provided by the railroad and under the direction of a foreman, was within the act.—Ramsay v. B. & O. (Ill.). 133 N. E. 703.

A blacksmith, injured while carrying a drawbar belonging to an engine used in interstate traffic, was held within the act—Glidewell v. Quincey, O. & K. C. (Mo. App.), 236 S. W. 677.

The Wisconsin Supreme Court holds that an employee sent from one town to another to make repairs on cars being used in interstate commerce, was engaged in interstate commerce when killed, on his way back, by a train engaged purely in interstate commerce.—Richter v. Chicago, M. & St. P. (Wis.), 186 N. W. 616.

The Iowa Supreme Court holds that a switchman of a terminal company moving an empty tank car having its origin out of the state, to the track of the owner, was engaged in interstate commerce precluding recovery under the Workmen's Compensation Act.—O'Neill v. Sioux City Terminal (Iowa), 186 N. W. 633.

Possibilities of Increased Suburban Service With Steam Operation

The Great Eastern Railway (England), according to F. V. Russell, its superintendent of operation, in an address before the British Ministry of Transport, had an intensive steam suburban service at London that many experts stated was incapable of improvement so far as the number of trains in rush hours was concerned, either on Saturday or ordinary week days. Nevertheless, without adopting any methods but those with which every capable railroad operator is thoroughly conversant, and diligently working on the lines of simplicity with close attention to detail, especially in the way of saving seconds wherever seconds could be saved, the rush period that was the least improved gave an increase in the number of trains of 50 per cent, and that which was most improved gave an increase of 75 per cent. The engines at their disposal were small six-coupled tanks, designed 36 years ago, the signals and points all being of the manual type. A further handicap being that, throughout a fairly large portion of their journey and in the most congested area, the trains have to run over the same tracks as main line trains. Also, near the London terminal there is a gradient of 1 in 70 for about half a mile, and tunnels on curves where signal visibility is indifferent. The density of the traffic can be gathered from the fact that 1,264 passenger trains were dealt with per day at Liverpool Street Station, in addition to many other movements, light engines, etc., the best headway of trains being two minutes.

Britain Gets Big Japanese Electrical Order

The Imperial Government Railways of Japan have just placed with the English Electric Company for their Dick-Kerr Works at Preston an order for 34 complete electric locomotives of a total value of upwards of £500,000. This represents the whole requirements of locomotives up to the end of 1923 for those sections of the main line railways which the Japanese government has decided to electrify at once. The order, it is said, was obtained in the face of keen foreign competition, particularly from America.

Eight of the locomotives now ordered are for heavy express passenger service. They are of the 2-C-C-2 (i.e. 4-6-6-4) type. Their weight is approximately 96 (long) tons and they are designed to haul a 415-ton train at a balancing speed of about 60 miles per hour. Each locomotive is equipped with 6 motors, each rated at 306 hp. at 500 volts, the motors being connected in two groups of three in permanent series on a trolley voltage of 1,500 volts. The control equipment is of the standard "English Electric" cam-shaft multiple unit type.

Of the remaining locomotives, nine are for local passenger service and 17 for heavy freight service. These 26 are all of the 4-4 type and will weigh approximately 56 tons each. They are equipped with four motors similar to those on the express passenger locomotives, but in this case the motors will be connected in two pairs in permanent series. Here too the control is the standard "English Electric" multiple unit type. The locomotives for local passenger service are designed to haul a 315-ton train and the freight locomotives a 600-ton train, the balancing speeds being about 55 and 40 miles per hour respectively.

$8,000,000 Placed in Contracts for French Electrification

A quantity of equipment for electrifying 125 miles of main line, including 80 freight locomotives and 80 passenger motor cars, is to be furnished to the Paris-Orleans Railway by a group of French manufacturers headed by the Compagnie Française Thomson-Houston. The Paris-Orleans Railway is one of the six large systems of France which operate something more than 5,000 miles of route. The Compagnie Française Thomson-Houston is the representative of the International General Electric Company. The 1,500-volt direct current system will be used and, according to dispatches received recently, this installation is the beginning of a more extensive program. The greater part of the equipment will be manufactured in France, but it is understood that considerable material of American manufacture will also be required.

The locomotives will be used on an extension of the original electrification, made about 25 years ago by the French Thomson-Houston Company. The first section of the new 1,500-volt section will cover 125 miles of main line between Paris and Vierzon. The motor cars will replace and extend the present suburban steam service out of Paris.

According to plans, high speed, through passenger service from Paris to Vierzon will be handled by 1,500-volt, direct current electric locomotives weighing 125 tons each and capable of regular running speeds of between 80 and 85 miles an hour. These locomotives are not included in the contracts thus far awarded, but the railway company is expected to announce the placing of this business at an early date and to give consideration soon to the purchase of additional locomotives for use in the Central Plateau Region.

Mechanical Division Issues Manual of Standard and Recommended Practice

The standard and recommended practice of the former American Railway Master Mechanics' and Master Car Builders' Associations has been consolidated and harmonized by appropriate committees of the Mechanical Division, American Railway Association, and together with practices adopted since amalgamation with the American Railway Association incorporated in a loose-leaf volume, designated "Manual of Standard and Recommended Practice, Mechanical Division, American Railway Association." This work has been done under the direction of the Committee on Manual.

This manual contains text and drawings for all standards and recommended practice adopted by letter ballot by the former Master Car Builders' and American Railway Master Mechanics' Associations and the Mechanical Division, American Railway Association, and is arranged in 12 sections, as follows:

A—Specifications for Materials.
B—Gages and Testing Devices.
C—Car Construction—Fundamentals and Details.
D—Car Construction—Trucks and Truck Details.
E—Brakes and Brake Equipment.
F—Locomotive Wheels, Tires and Miscellaneous Locomotive Standards.
G—Safety Appliances for Cars and Locomotives.
H—Train Lighting, Headlights and Classification Lamps.
I—Rules for Fuel Economy on Locomotives.
J—Inspection and Testing of Locomotive Boilers and Rules and Instructions for Inspection and Testing of Steam Locomotives and Tenders.
K—Specifications for Tank Cars.
L—Miscellaneous Standards and Recommended Practice.

The pages in each of these sections are numbered consecutively

and each section is provided with separate index. There is also a general index of the contents of the entire manual with proper reference to section and page.

The Code of Rules Governing the Condition of and Repairs to Freight and Passenger Cars for the Interchange of Traffic, and the Rules Governing the Loading of Lumber, Logs, Stone, etc., and Loading and Carrying of Structural Materials, Plates, Rails, Girders, etc., while adopted standards are not published in this manual.

The manual contains nearly 1,000 pages of text and drawings and is bound in special hinged back binder, so that it may be kept up to date by issuing from time to time corrected pages without the necessity of printing the entire book. It will also be possible to secure separate sheets covering only such matter as is desired without the necessity of purchasing the entire book.

This manual will be supplied on requisition at the following prices:

To members of the association:

Manual complete, including binder, per copy	$6.00
Separate sections, complete, self-covered in paper, per copy	.50
Separate sheets, each	.05

To other than members of the association the manual is sold at double the prices quoted.

MEETINGS AND CONVENTIONS

General Foremen's Convention Cancelled

Owing to the present railroad conditions, the officers and the executive committee of the International Railway General Foremen's Association have cancelled the 1922 convention.

Master Blacksmiths' Convention Cancelled

Owing to the unsettled conditions resulting from the railway shop mens' strike, the executive committee of the International Railway Master Blacksmiths' Association has issued notices cancelling the 1922 convention. Arrangements had been made to hold the meeting at the Hotel Sherman, Chicago, August 15 to 17, inclusive.

Annual Safety Congress Next Month

The Eleventh Annual Safety Congress will be held in Detroit, Mich., from August 28 to September 1. In the past this conference, which is promoted by the National Safety Council, a co-operative non-commercial organization of men, industries and communities interested in the prevention of accidents, has annually brought together 3,000 or more persons who are actively engaged in safety work in both the United States and Canada. This year invitations will be sent to 15,000 executives and safety workers and a large attendance is expected. Complete discussions of the various phases of industrial and public safety will be conducted at the meetings of the 20 different sections into which the council's activities are divided. These meetings will cover safety problems in a wide variety of fields. The steam railroad section will hold sessions on Tuesday and Wednesday, August 28 and 29. The subjects covered will include "Safety and Publicity," "Accident Prevention from the Standpoint of the Operating Department," "Report of Progress—Careful Crossing Campaign" and "Safety as Seen from the Pulpit."

Meeting of Electric Steel Founders' Research Group

Officers and operating officials of each plant holding membership in the Electric Steel Founders' Research Group held one of their regular meetings for several days immediately following the convention of the American Foundrymen's Association at Rochester, N. Y. The group meeting was held at East Aurora, N. Y., because of its accessibility to Rochester where the group members had participated in the foundrymen's annual meeting. C. R. Messinger of Milwaukee, who is very active in this research group and is prominently connected with several foundry concerns, including the Sivyer Steel Casting Company, was selected at Rochester as the next president of the American Foundrymen's Association.

Recently there appeared in the technical press an extensive description of the co-operative technical plan followed by this research group which is made up of representatives of the Electric Steel Company, Chicago; the Fort Pitt Steel Casting Company, McKeesport, Pa.; the Lebanon Steel Foundry, Lebanon, Pa.; the Michigan Steel Casting Company, Detroit, Mich., and the Sivyer Steel Casting Company, Milwaukee, Wis. At the convention of the American Foundrymen's Association the results of comprehensive investigations in testing molding sand were presented by R. J. Doty of the Sivyer Company who had been delegated by the group to carry on such a research for its own account. The group made some of its information on the subject available to the industry at large. The result of this, as announced at the convention, has aroused great interest, particularly as it was stated there that certain testing methods developed by the research group have been approved by the sub-committee on tests of the Joint Committee on Molding Sand Research organized by the American Foundrymen's Association and the National Research Council, and participated in officially by the American Society for Testing Materials and numerous technical departments and bureaus of the United States Government.

It is stated that at East Aurora further steps for the group molding sand investigation were planned and interesting reports were presented by the members on annealing, electric furnace practice, the elimination of slag in castings, and other matters that now engage the attention of the group members.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. 1923 annual convention; Denver, first Tuesday in May.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago.

Division V.—Purchase and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago. Annual convention will be held at the Hotel Sherman, Chicago, September 5-8.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Stuebing, 2201 Woolworth Building, New York.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention and exposition postponed until October 2-7, 1922, Detroit, Mich.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Regular meeting second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago, Ill.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Meeting second Thursday in January, March, May, September and November, Hotel Iroquois, Buffalo, N. Y.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill. Annual convention August 22-24, Chicago.

Cincinnati Railway Club.—W. C. Cooder, Union Central building, Cincinnati, Ohio. Regular meetings second Tuesday, February, May, September and November.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich. The 1922 annual convention has been cancelled.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. The 1922 annual convention has been cancelled.

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Regular meetings second Tuesday each month except June, July, August and September, Copley Plaza Hotel.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Regular meetings third Friday of each month, except June, July and August, at 29 West Thirty-ninth street, New York.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Regular meetings second Thursday of each month in San Francisco and Oakland, Cal., alternately.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meetings fourth Thursday in each month, except June, July and August, at Fort Pitt Hotel, Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Regular meetings second Friday each month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth street, Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago Regular meetings third Monday of each month, except June, July and August.

SUPPLY TRADE NOTES

Isaac Joseph, who was the founder of the Edna Brass Manufacturing Company, Cincinnati, Ohio, and its president for over 20 years, died on May 23.

H. F. Barrus, sales manager of the Union Twist Drill Company, Athol, Mass., has resigned to enter business with the firm of Barrus & Cullen, Ltd., London, England.

N. E. Gage, formerly connected with the Standard Tool Company, Cleveland, Ohio, has recently been appointed sales manager of the National Tool Company of that city.

Harvey E. Miller, vice-president of the Fairbanks Company, New York City, died on July 9 of injuries he received in the Atchison, Topeka & Santa Fe collision at Burrton, Kan.

The offices of the Air Reduction Sales Company, formerly maintained at 120 Broadway and 160 Fifth avenue, New York, have been consolidated with the executive office at 342 Madison avenue.

The Younglove Construction Company, Sioux City, Ia., has been appointed representative of the Conveyors Corporation of America, Chicago, Ill., for the sale of American trolley carriers in northwestern Iowa and South Dakota.

K. C. Gardner, formerly general sales manager, central district, of the Pressed Steel Car Company, is now associated with the Greenville Steel Car Company, Greenville, Pa., as vice-president in charge of sales. Mr. Gardner's headquarters are at Greenville.

The Greenville Steel Car Company, Greenville, Pa., is erecting a new building 75 ft. by 390 ft. in which the company plans to install its present fabricating equipment. The company has heretofore only repaired and rebuilt steel equipment but will in the future also build new freight cars.

The Pilliod Company, Swanton, Ohio, manufacturers of the Baker locomotive valve gear, with New York office at 30 Church street, has secured control of the Southern Valve Gear Company. The former offices of the Southern Valve Gear Company located at Knoxville, Tenn., have been discontinued.

A. A. Murphy has been appointed resident sales manager of the industrial and railway paint and varnish division of the E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. He will be located at the new office the paint and varnish division has opened at 30 Church street, New York City.

The Wilson Welder & Metals Company, Inc., 132 King street, New York City, recently appointed the King-Knight Company, Underwood building, San Francisco, Cal., exclusive representatives in central and northern California for Wilson plastic-arc welding machines and Wilson Color-Tipt metals.

C. C. Clark has been appointed assistant general sales manager of the Pressed Steel Car Company and the Western Steel Car & Foundry Company, in charge of sales matters in the central district, with headquarters in the Farmers Bank Building, Pittsburgh, Pa., taking the place of K. C. Gardner, resigned.

C. M. Jacobsen has joined the service staff of the Franklin Railway Supply Company, New York, and is now in charge of Southern territory with headquarters at Atlanta, Ga., relieving B. C. Wilkerson, who has been appointed a special service representative of the company on locomotive booster applications.

A. R. Kipp, mechanical superintendent of the Minneapolis, St. Paul & Sault Ste. Marie with headquarters at Minneapolis, has resigned to form a partnership with F. L. Battey, consulting engineer specializing in railroad shop and industrial plant design and construction shop operating problems, with offices in the Union Fuel building 123 West Madison street, Chicago.

The U. S. Light & Heat Corporation, of California, has been incorporated as a subsidiary of the U. S. Light & Heat Corporation, Niagara Falls, N. Y. A site has been leased and construction started on a new plant at Oakland, Cal. The new plant is to handle the company's business on the Pacific Coast, and it is expected that production will start in the new factory about October 1.

Johns-Manville, Inc., New York, will build a new plant in Canada at Asbestos, Quebec, for the manufacture of asbestos. Work is to be started at once on the plant and is expected to be completed in about six months. The plant will cost over $1,000,000 and will give employment to about 300 people. The company has taken over the Bennett-Martin mine at Thetford Mines, Que.

H. D. Shute, vice-president and general sales manager of the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has been elected a member of the board of directors of the Standard Underground Cable Company, Pittsburgh. A. B. Saurman, general sales manager of the Standard Underground Cable Company, Pittsburgh, has been elected vice-president in addition to his other duties.

Anson W. Burchard, vice-chairman of the board of directors of the General Electric Company, Schenectady, N. Y., has been elected president and chairman of the board of the International General Electric Company, succceding Gerard Swope, its former president, who was recently chosen president of the General Electric Company. He also succeeds Charles Neave, former chairman of the International Company, who has resigned.

A. C. Haberkorn, formerly Detroit branch manager of Manning, Maxwell & Moore, Inc., and the Biggs-Watterson Company, and E. E. Wood, former sales manager of the Jones & Lamson Machine Company, have formed a partnership under the name of Haberkorn & Wood, with an office and warehouse at 620 E. Hancock avenue, Detroit, Mich., to handle a line of machine tools, cutting oils and compounds, also permanent mould aluminum alloy castings.

W. H. White will in the future be in charge of the New York City business of the Mahr Manufacturing Company, Minneapolis, Minn., makers of Mahrvel oil burning equipment. Mr. White's headquarters will be at 56 Murray street, New York City. He has devoted all his time to mechanical work both in the shops and on the road, having served in the steel and iron businss for the past 10 years. Until recently he was with B. M. Jones & Company, Inc., New York.

Joseph H. Towle, who joined the selling forces of the National Railway Appliance Company of New York, some time ago, is now in charge of the company's new Pennsylvania headquarters at Harrisburg, Pa., where an office was recently opened at 85 Union Trust building. Mr. Towle was formerly with the Railway Improvement Company, New York, as sales engineer. The National Railway Appliance Company is now selling a new product known as Tnemec paint. The principal use of this material is the protection and rust-proofing of metals and other materials.

O. R. Hildebrant will in future represent the railway sales department of the U. S. Light & Heat Corporation, Niagara Falls, N. Y., in the southeastern territory with headquarters at Norfolk, Va. Mr. Hildebrant began work in 1905 with the Pennsylvania at Jersey City, N. J. In 1909 he went to the Safety Car Heating & Lighting Company and later was with the Edison Storage Battery Company as chief inspector and sales engineer until February, 1918. He then entered the employ of the U. S. Light & Heat Corporation, as representative in the southeastern district, which position he held until November, 1920, when he again entered railroad work on the Florida East Coast. He now returns to the service of the U. S. Light & Heat Corporation as above noted.

W. B. Murray, chief engineer of the Miller Train Control Corporation, with headquarters at Danville, Ill., has been elected vice-president of that organization in addition to his present office Mr. Murray was born at Dunkirk, N. Y., on August 5, 1875. He entered railroad service in 1893 and was successively a fireman and engineer of the Portland, Mt. Tabor Railway, Portland, Ore., until 1897. From that date until 1899 he was engaged in engineering studies at New Haven, Conn. In 1900 he entered the service of the Hill & Miller Electrical Company, Washington,

D. C., as construction engineer. Two years later he became chief engineer of Palais Royal and in 1905 he was general manager of the Murray Engineering & Construction Company, while from 1907 to 1911 he was a consulting engineer. He first became connected with the Miller Train Control Corporation in 1909, and since 1911 he has devoted his entire time to this organization.

The Dressel Railway Lamp & Signal Company, Arlington, N. J., has been incorporated with A. D. Hobbie, president and treasurer, F. Hallett Lovell, Jr., vice-president, F. W. Dressel, vice-president, and L. L. Pollak, secretary. The new company succeeds the Dressel Manufacturing Corporation, formerly known as the Dressel Railway Lamp Works, New York City, originally established in 1882, with factory formerly located at 3860-80 Park avenue, New York City. All the officers of the new company have for a long time been identified with the railroad lighting and signal field. Increased facilities and equipment have been acquired at the new plant located at Arlington. The company recently developed and made improvements in electric headlights, switch and signal lamps and intends to bring out in addition a number of new devices. A. D. Hobbie is also vice-president and general manager of F. H. Lovell & Co., Arlington, and he has been active in the railroad field for over 20 years. F. Hallett Lovell, Jr., is president and treasurer of F. H. Lovell & Co., and was president of the Klaxon Company until it was taken over by the General Motors Company. F. W. Dressel has a long record as a lighting expert in signal and maintenance of way departments and was for a number of years president of the Dressel Lamp Works. L. L. Pollak has been for a number of years, production manager of F. H. Lovell & Co.

F. W. Dressel

A. D. Hobbie

G. A. Woodman has been appointed sales manager of the Northwestern Malleable Iron Company, Milwaukee, Wis., with offices at 237 Railway Exchange building, Chicago. He will have charge of the sales of the Joliet journal box which was formerly handled by the Joliet Railway Supply Company, Chicago, now the Republic Railway Equipment Company, of the same city. Mr. Woodman was born at Dunkirk, N. Y. on August 21, 1866. On August 21, 1883, he entered the service of the Brooks Locomotive Company as a machinist apprentice and was successively thereafter, in the drafting department, same company; mechanical engineer, Lima Locomotive & Machine Company; assistant master car builder Swift & Co., Chicago; assistant superintendent, American Car & Foundry Company, Chicago; mechanical engineer, Kirby Equipment Company, Chicago, when that company sold the Woodman journal box, the name of which was later changed to the Franklin journal box; and the National Car Equipment Company, Chicago. He retired two years ago and had been inactive in the railway supply business up to the time of his recent appointment.

W. H. Marshall, formerly president of the American Locomotive Company, is chairman of the board of directors of the new company and C. K. Lassiter, formerly vice-president of the American Locomotive Company in charge of operation, is president of the new company. H. J. Bailey, H. W. Breckenridge, H. W. Champion, J. J. Dale and A. H. Ingle are vice-presidents; O. D. Miller, treasurer; and R. R. Lassiter, secretary. The directors include W. H. Marshall, C. K. Lassiter, H. J. Bailey, formerly president Hilles & Jones Company; B. J. Baker, of B. J. Baker & Company, bankers; H. W. Breckenridge, formerly vice-president of the Colburn Machine Tool Company; Lawrence Chamberlain, president of Lawrence Chamberlain & Co., bankers; H. W. Champion, formerly president of the Newton Machine Tool Works, Inc.; J. J. Dale, president of the Dale Machinery Company; T. Allen Hilles, A. H. Ingle, formerly president of the Betts Machine Company and Ingle Machine Company, and F. D. Payne, formerly manager of Modern Tool Company.

W. Woodward Williams has been appointed vice-president of the Titan Iron & Steel Company, Newark, N. J. Mr. Williams' experience in the iron and steel industry began immediately upon his graduation from Harvard University in 1905. After six years in the mills of the Carnegie Steel Company at Pittsburgh, Duquesne, Pa., and Youngstown, Ohio, he entered the sales department of the Bourne-Fuller Company of Clece-land, Ohio, and was later appointed manager of its Pittsburgh office. In January, 1914, he became general manager of sales of the A. M. Byers Company, Pittsburgh, and subsequently was made general manager. In August, 1919, he became general manager of the Reading Iron Company, being later elected vice-president in charge of sales and operation. In September, 1920, he became associated with the Pittsburgh Gage & Supply Company, jobbers of wrought iron merchant pipe. He resigned the vice-presidency of this company on May 31 of this year, entering immediately upon his present office of vice-president of the Titan Iron & Steel Company.

W. W. Williams

Attorney General Approves Steel Merger

In response to a Senate resolution Attorney General Daugherty has transmitted to the Senate a report stating that in his opinion the merger of the Bethlehem and Lackawanna steel companies and the proposed merger of the Midvale, Republic and Inland companies are not in violation of the Sherman, Clayton or Webb laws and that there is no reason to believe that restraint of trade or monopolistic control will result. He did not express his opinion as to whether they are in violation of the federal trade act. The Federal Trade Commission is conducting an investigation on this point in accordance with the Senate resolution.

The Consolidated Machine Tool Corporation of America

The Consolidated Machine Tool Corporation of America, with general offices at 17 East Forty-second street, New York City, is a consolidation of the Betts Machine Company, Rochester, N. Y.; Ingle Machine Company, Rochester, N. Y.; Hilles & Jones Company, Wilmington, Del.; Modern Tool Company, Erie, Pa.; the Newton Machine & Tool Works, Inc., Philadelphia, Pa.; the Colburn Machine Tool Company, Cleveland, Ohio, and the Dale Machinery Company, Inc., New York City and Chicago, Ill. The company's capital stock includes $10,000,000 preferred stock of $100.00 par value and 200,000 shares of common stock with no par value.

TRADE PUBLICATIONS

SUPERHEATERS FOR STATIONARY POWER PLANTS.—Bulletin T-1, issued by The Superheater Company, New York, describes the Elesco superheaters for stationary power plants.

LOCOMOTIVE LUBRICATION.—The May issue of "Lubrication," the monthly publication of The Texas Company, New York, contains an important article on the lubrication of superheated locomotives.

MACHINE TOOLS.—The Armstrong Manufacturing Company, Bridgeport, Conn., has issued catalogue No. 17 listing and illustrating its line of stocks and dies, water, gas and steam fitters' tools and pipe threading machines.

BALL BEARINGS.—The Skefko Ball Bearing Company, Luton, England, has issued a catalogue describing S K F ball bearing transmission accessories, etc. The S K F Industries, New York, is the American manufacturer and representative.

CONDENSER TUBE PACKING.—The Crane Packing Company, Chicago, has issued a booklet describing the John Crane metallic rings for condenser tube sheets and giving the reasons why packing of this character is superior to corset lace, wicking and wood or fibre bushings.

POWER HOE.—Book 444 describes the power hoe or improved drag scraper made by the Link-Belt Company, Philadelphia, Pa. The power hoe is particularly valuable in many places for storing and reclaiming coal, sand, gravel, and other bulk materials. Illustrations show a number of applications.

HEATING AND POWER PLANT SPECIALTIES.—The McAlear Manufacturing Company, Chicago, is distributing catalogue No. 27, which illustrates many new devices, including an individual temperature control valve, specialties for power plants, vacuum and vapor heating systems, and plumbing systems.

MEASURING TOOLS.—The Van Keuren Company, Boston, Mass., has issued a new catalogue illustrative and descriptive of combination precision gage blocks, gage block accessories, plug gages, measuring wires for screw threads and profile gages, lapped steel surface plates and light wave measuring outfits.

HYDRAULIC PUMPS.—A booklet entitled "Trade Standards in the Pump Industry" has been issued by the Hydraulic Society, C. H. Rohrbach, 50 Church street, New York, secretary. The information given will be found useful by those who have occasion to specify or purchase hydraulic pumps of various kinds.

SHOCK INSULATED BUS.—The International Motor Company, New York, has issued a bulletin describing the Mack rubber shock insulator as applied to the spring shackle block. The applications shown are to highway buses, but practically the same shock insulator, however, is now in use on rail motor cars.

MECHANICAL STOKER.—The Elvin Mechanical Stoker Company, New York, has issued bulletin 101, containing very complete information in regard to the Elvin mechanical stoker. A description is given of the various parts of the mechanism, together with information relative to the application of the stoker to a locomotive.

RAILROAD SHOP EQUIPMENT.—The Whiting Corporation, Harvey, Ill., has issued a catalogue of 48 pages outlining the advantages and labor-saving features of its locomotive hoists, coach hoists, cranes, transfer tables and turntable tractors. For the use of those contemplating new shops, a model shop layout, showing the most practical and economical arrangement of equipment, has been included; also a typical layout for a wheel foundry having a capacity of 250 wheels per day. This catalogue, No. 160, supersedes No. 145.

STEEL WHEELS AND CIRCULAR FORGINGS.—The Carnegie Steel Company, Pittsburgh, Pa., has printed new editions of two of their booklets. The first covers wrought steel wheels for steam and electric service and contains drawings, specifications and considerable valuable data. Wheels for steam railway service include those for engine trucks, tender trucks, passenger train cars, freight cars and motor cars for electrified service. The second booklet shows such circular forgings as locomotive piston blanks, pipe flanges, shaft couplings, gear blanks, crane track wheels, etc.

EQUIPMENT AND SHOPS

Locomotive Orders

THE DELAWARE, LACKAWANNA & WESTERN has ordered 5 Pacific type and 25 Mikado type locomotives from the American Locomotive Company.

THE BALTIMORE & OHIO has ordered 35 Mikado type locomotives from the Baldwin Locomotive Works. This road is also having repairs made to 25 locomotives at the Baldwin shops.

THE CHICAGO & EASTERN ILLINOIS has ordered 10 Mikado type locomotives from the American Locomotive Company and six Pacific type locomotives from the Lima Locomotive Works.

THE ILLINOIS CENTRAL has ordered 15 switching locomotives from the Baldwin Locomotive Works, 25 Santa Fe type locomotives from the Lima Locomotive Works and 25 Mikado locomotives from the American Locomotive Company.

THE NEW YORK CENTRAL has announced that in anticipation of the motive power requirements of 1923 and to protect the expected traffic needs of the winter in the territory served by the New York Central lines, orders have just been placed for the construction of 150 modern freight locomotives. The locomotives are to be the Mikado type, identical in design with Michigan Central locomotive 8,000, described in this issue. It is understood that the order has been divided equally between the American Locomotive Company and the Lima Locomotive Works, Inc.

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Locomotive Repairs

THE NEW YORK CENTRAL is having 50 locomotives overhauled at the shops of the Baldwin Locomotive Works.

THE NEW YORK, NEW HAVEN & HARTFORD will have repairs made to 25 locomotives at the shops of the Baldwin Locomotive Works and to 10 locomotives at the shops of the American Locomotive Company.

THE LEHIGH VALLEY is having 5 Consolidation type and 10 switching locomotives repaired at the shops of the American Locomotive Company and 6 Consolidation type and 9 switching locomotives at the shops of the Baldwin Locomotive Works.

THE ERIE has entered into a contract for the repair of 20 locomotives a month for a period of six months at the American Locomotive Company's Cooke Works and will have repairs made to 15 locomotives, including Santa Fe and Mikado types, at the shops of the Baldwin Locomotive Works.

Freight Car Orders

THE UNITED VERDE COPPER COMPANY has ordered 24 ore cars from the Pressed Steel Car Company.

THE GREAT NORTHERN has ordered 300 underframes from the Minneapolis Steel & Machinery Company.

THE WESTERN PACIFIC has ordered 2,000 refrigerator cars from the American Car & Foundry Company.

THE NORTHERN REFRIGERATOR CAR COMPANY has ordered 500 refrigerator cars from the Pullman Company.

THE NORTHERN PACIFIC has ordered 70 express refrigerator cars from the American Car & Foundry Company.

THE MANILA RAILROAD COMPANY has ordered 50 cane cars of 30 tons' capacity from the Koppel Industrial Car & Equipment Company.

THE ARGENTINA STATE RAILWAYS have placed an order with the Standard Steel Car Company for 100 ballast cars.

THE PITTSBURGH & WESTERN VIRGINIA has ordered 1,000 hopper cars of 55 tons' capacity from the Cambria Steel Company.

THE DELAWARE, LACKAWANNA & WESTERN has given an order for 370 gondola car bodies to the American Car & Foundry Company.

THE ALABAMA & VICKSBURG has ordered from the Kilbourne & Jacobs Manufacturing Company 25 all-steel automatic air dump cars of 40 tons' capacity.

THE PHILADELPHIA & READING has ordered 500 cars of 70 tons' capacity from the Pressed Steel Car Company and 500 from the Standard Steel Car Company.

THE SOUTHERN PACIFIC has ordered from the Kilbourne & Jacobs Manufacturing Company 40 all-steel automatic air dump cars with improved apron attachment of 40 tons' capacity.

THE NASVILLE, CHATTANOOGA & ST. LOUIS has ordered 500 40-ton single sheathed box cars, 250 40-ton double sheathed box, 150 40-ton stock and 100 50-ton flat cars from the American Car & Foundry Company.

THE ILLINOIS CENTRAL has ordered 1,000 from the Pullman Company, 500 from the American Car & Foundry Company, 500 from the Mt. Vernon Car Manufacturing Company, 500 from the Bettendorf Company and 500 from the Western Steel Car & Foundry Company.

THE TEXAS & PACIFIC will build 532 freight cars in its shops at Marshall, Tex., as soon as the shopmen's strike is settled. This is the first authorization of a total 1,100 cars which are to be built in these shops, the company already having the necessary material on hand for the construction of the initial lot.

THE NORTHERN PACIFIC reported in the July *Railway Mechanical Engineer* as having placed orders for a large number of miscellaneous freight cars, has ordered in addition 250 gondola cars from the Standard Steel Car Company and 250 general service gondola cars from the General American Car Company.

THE NORFOLK & WESTERN has divided an order for 2,000 hopper cars of 70 tons' capacity as follows: American Car & Foundry Company, 500 cars; Standard Steel Car Company, 500; and Pressed Steel Car Company, 1,000. The company has also ordered 1,000 single sheathed box cars of 50 tons' capacity from the Ralston Steel Car Company.

Freight Car Repairs

THE ILLINOIS CENTRAL has contracted with the Ryan Car Company for the repair of 600 gondola cars.

THE CHICAGO, BURLINGTON & QUINCY will have 500 box cars repaired at the shops of the Streator Car Company and 500 steel gondolas at the shops of the American Car & Foundry Company.

THE NEW YORK CENTRAL will have repairs made to 500 freight cars at the shops of the Ryan Car Company and to 500 cars at the shops of the Buffalo Steel Car Company.

THE CENTRAL VERMONT will have repairs made to 200 steel gondola cars, 100 wooden underframe box cars and 400 steel underframe box cars at the shops of the American Car & Foundry Company.

THE CHICAGO GREAT WESTERN has placed orders for the repair of 200 cars with the Pullman Company, 154 cars with the Sheffield Car & Equipment Company, Kansas City, Mo., and 173 cars with the Siems Stembel Company, St. Paul Minn.

THE NEW YORK, NEW HAVEN & HARTFORD has given a contract to the Keith Car & Manufacturing Company, Sagamore, Mass., for rebuilding 6,000 bad-order freight cars. The company also has a large number of additional cars awaiting repairs.

Shop Construction

MISSOURI PACIFIC.—This company has awarded a contract to the T. S. Leake Construction Company, Chicago, for the construction of a car repair shed at Sedalia, Mo., to cost approximately $25,000.

CHICAGO, BURLINGTON & QUINCY.—This company has awarded a contract to the Great Lakes Construction Company, Chicago, for the construction of a power plant at Aurora, Ill. This company has also awarded a contract for the construction of a new roundhouse at Rock Island, Ill., to G. A. Johnson & Sons, Chicago.

CHESAPEAKE & OHIO.—This company has awarded a contract for the construction of terminal facilities at Peach Creek, W. Va., involving a five-stall engine house addition, a shop, storehouse and power house, and for the construction of a five-stall addition to its roundhouse and shop at Peru, Ind., to Joseph E. Nelson & Sons, Chicago, the work at Peru and Peach Creek to involve expenditures of approximately $125,000 and $350,000, respectively.

Machinery and Tools

THE LONG ISLAND has ordered a 150-ton overhead traveling crane from the Whiting Corporation for its Morris Park shops.

PERSONAL MENTION

GENERAL

J. E. OSMER has been appointed superintendent of motive power of the Denver & Salt Lake, with headquarters at Denver, Colo.

PURCHASING AND STORES

W. P. DITTOE has been appointed purchasing agent of the Lake Erie & Western, with headquarters at Cleveland, Ohio, succeeding W. P. Winter, resigned.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

A. MAYS, general foreman of the Canadian National, has been appointed assistant master mechanic, with headquarters at Big Valley, Alberta, succeeding W. L. Loomis, transferred.

SHOP AND ENGINEHOUSE

CHARLES HITCHCOCK has been appointed erecting shop foreman of the Santa Fe, with headquarters at Richmond, Cal.

P. SPENCE, locomotive foreman of the Canadian National, has been appointed general foreman at Edmonton, Alberta, succeeding A. Mays.

CAR DEPARTMENT

J. K. NESBITT has been appointed car foreman of the Canadian National, with headquarters at Edmonton, Alberta.

W. K. SMITH has been appointed car foreman of the Rock Island at Chickasha, Okla., succeeding W. J. Logsdon, deceased.

M. MEEHAN has been appointed master car repairer of the Western division of the Southern Pacific, Pacific system, with headquarters at West Oakland, Cal., to succeed H. Englebright, retired.

OBITUARY

WILLIAM C. ARP, retired superintendent of motive power of the Vandalia (now a part of the Pennsylvania), whose death on June 16 was reported in the July issue of the *Railway Mechanical Engineer*, was born on June 30, 1848, near Williamsport, Pa., and entered railway service as a machinist apprentice on the Northern Central (now a part of the Pennsylvania) at Williamsport. Following his apprenticeship he engaged in stationary engine and mill work at Williamsport until 1875, when he was advanced to roundhouse foreman. He continued thereafter as roundhouse foreman and as foreman of engines of the Middle division until 1883, when he was promoted to general foreman of shops of the Pennsylvania lines west of Pittsburgh, at Indianapolis, Ind. In 1886 he became roundhouse foreman of the Pennsylvania, at Columbus, Ohio, and a year later was promoted to master mechanic at Logansport, Ind. He served later in the same capacity at Dennison, Ohio, until January 15, 1896, when he was promoted to superintendent of motive power of the Terre Haute & Indianapolis, a position he continued to hold following the acquisition of this property by the Vandalia until the date of his retirement in 1918.